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ARTS

THE IMPACT OF AI ON VISUAL ARTS

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Abstract

The integration of artificial intelligence (AI) into visual arts has prompted significant shifts in artistic practices, creativity, and the concept of authorship. AI technologies, such as generative adversarial networks (GANs) and neural networks, are now actively involved in the creation of art, producing works that challenge traditional notions of creativity. This paper explores the evolving relationship between art and technology, focusing on the transition from pre-AI to post-AI creative processes. It examines key case studies of AI-generated art, such as *Portrait of Edmond de Belamy* and Refik Anadol's data sculptures, to understand the ways in which AI tools are reshaping artistic expression. The study also addresses the philosophical and ethical implications of machine-generated art, including questions about authorship, originality, and the role of the human artist. Ultimately, this paper highlights the opportunities and challenges AI presents to the future of the visual arts, reimagining the boundaries of creativity and artistic identity.

Keywords: Artificial Intelligence, Visual Arts, Creativity, Authorship, GANs, Digital Art

Introduction

The intersection of artificial intelligence (AI) and visual arts represents one of the most intriguing developments in contemporary creative practices. While technology has historically played a role in shaping art—whether through the invention of the camera, the development of digital media, or the use of computational tools—AI introduces a new dimension by enabling machines to actively participate in the creative process. What was once considered a uniquely human endeavor is now being increasingly shaped by algorithms, neural networks, and data-driven systems, leading to profound questions about the nature of creativity and authorship in art [8].

Traditionally, art has been seen as a deeply personal and emotional expression, with the artist's vision and skill at the core of the creative process. From the Renaissance masterpieces of da Vinci and Michelangelo to the abstract experiments of Jackson Pollock and Mark Rothko, artists have always sought to express their unique perspectives on the world. The tools they used—brushes, paint, chisels, or cameras—served as extensions of their creative capacities [9]. The notion that creativity stems from the human mind and emotions has been central to the philosophy of art for centuries [7].

However, the advent of AI challenges this traditional view by blurring the lines between human and machine-generated creativity. AI technologies, particularly deep learning algorithms like generative adversarial networks (GANs), have the ability to "learn" from vast datasets of existing artworks, mimicking styles, techniques, and forms, and then generating new pieces that are often indistinguishable from human-created art. This raises important philosophical and ethical questions: Can a machine be creative? Does the involvement of an AI in the creation of art devalue the artist's role? And, importantly, who owns the rights to a piece of art created by an AI?

These questions are not just academic—they have real-world implications for artists, collectors, critics, and audiences. For example, AI-generated art has made its way into high-profile auctions, with pieces selling for hundreds of thousands of dollars, forcing the art world to confront the question of whether a machine can truly create something of value. At the same time, the growing accessibility of AI tools has democratized the creative process, empowering new generations of artists to experiment with these technologies and explore new forms of expression.

This paper aims to explore the impact of AI on visual arts by examining how AI technologies have reshaped the ways in which artists approach their work, the questions these changes raise about the nature of creativity and authorship, and the broader implications of AI's growing role in the artistic landscape. The paper will also trace the evolution of art-making from pre-AI techniques to the present day, highlighting key moments where technological innovations have influenced artistic practices and led to new modes of artistic expression. Through a comparative analysis, the study will explore how the rise of AI is transforming the way we understand and experience art, challenging long-held assumptions about the role of the artist and the meaning of creativity in the digital age.

Literature Review

Before the advent of AI, technological advancements in art were typically limited to tools such as brushes, canvas, and photography. Historical shifts, like the introduction of photography in XIX century or the use of digital tools in the late XX century, significantly impacted the way artists worked. However, AI stands apart because it introduces a degree of autonomy in the creative process, enabling machines to create without human intervention or direction.

Several scholars have explored the influence of technology on art creation. McCormack et al. (2019)

discuss how AI systems like generative adversarial networks (GANs) have become a central tool in digital art creation, offering new possibilities for image generation and manipulation [5]. Elgammal et al. (2017) examine the use of neural networks in art and propose that AI can be seen as a new artistic medium rather than merely a tool [4]. Other researchers, such as McVeigh (2020), investigate the ethical implications of AI-generated art, focusing on issues like copyright, authorship, and originality [6].

Methodology

1. Case Studies of AI-Generated Art

The second part of the methodology involves the selection and analysis of prominent case studies in AI-generated art. These case studies are used to illustrate how AI is currently being employed in the creative process and to highlight both the potential and the limitations of machine-generated artwork.

Key examples include:

- **Obvious' Portrait of Edmond de Belamy (2018)**: A portrait created by the Paris-based art collective Obvious using a GAN. The work made headlines when it was auctioned at Christie's for $432,000, sparking debates about the nature of art and authorship [3].
- **Refik Anadol's Data Sculptures**: Anadol's AI-driven installations use real-time data to create immersive visual experiences, blending the digital with the physical to explore the intersection of technology and creativity [1].
- **AI-Generated Music and Art Projects**: While not strictly limited to visual art, projects like *Dada's GAN-generated poetry* or *Artbreeder*—a platform that allows users to blend images and create new artworks using AI—offer valuable insights into the role of AI in collaborative creativity [2].

In examining these works, the paper analyzes the specific AI tools and techniques used (such as GANs, style transfer, and neural networks), the involvement of human artists in the creative process, and the reception of these works by the public and critics. By analyzing these case studies, the paper aims to understand how AI is being integrated into traditional art-making practices and how it challenges conventional notions of artistic authorship and originality.

2. Interviews with Artists and Art Critics

To gain deeper insight into the experiences and perspectives of practitioners in the field, the study includes qualitative interviews with contemporary artists who use AI as part of their creative process, as well as art critics who have written about AI-generated art. These interviews focus on several key areas: The motivations behind using AI in their artistic practices, the perceived advantages and challenges of working with AI as a creative tool, opinions on the ethical implications of AI art, particularly concerning authorship, originality, and the art market, the impact of AI tools on their traditional artistic methods and how AI has influenced their broader creative vision.

These interviews serve as a means of bridging the gap between theoretical analysis and practical experience, offering valuable insights into the day-to-day use of AI in art creation. Additionally, the conversations with critics and curators help contextualize the broader reception of AI art within the art world.

3. Comparative Analysis: Pre- and Post-AI Artistic Practices

To better understand the shift in artistic practice with the advent of AI, the study employs a comparative analysis of traditional (pre-AI) and contemporary (post-AI) artistic techniques. This analysis focuses on the following aspects:

- **Process**: How has the introduction of AI tools transformed the steps involved in creating visual art? In the pre-AI era, artists would sketch, paint, or carve by hand, relying heavily on their skill and intuition. Today, artists can use AI to generate preliminary designs, experiment with different styles, or even allow the machine to complete certain parts of the artwork.
- **Style and Aesthetics**: How has AI affected artistic styles? Pre-AI art movements like Impressionism, Cubism, and Surrealism were driven by specific philosophical and aesthetic ideals. Post-AI art, on the other hand, allows for more fluid experimentation, producing works that might blend multiple styles, create unexpected forms, or even challenge traditional concepts of beauty and representation.
- **Creativity**: The concept of creativity is central to this comparison. In traditional art, creativity was viewed as an entirely human trait, often linked to intuition, emotion, and individual perspective. The introduction of AI challenges this view, as machines can now generate "novel" compositions based on data rather than emotional or intellectual insight. The paper investigates whether this constitutes true creativity or if AI simply mimics human-generated content in a novel way.

By comparing historical and contemporary methods, the study highlights the profound changes in the way art is conceptualized, produced, and consumed. It also explores how AI's role in the creative process has shifted the artist's role from sole creator to that of a collaborator with the machine.

4. Theoretical Framework: Creativity and Authorship

The theoretical lens for this study is drawn from both art theory and philosophy of technology. The paper engages with questions about the nature of creativity, authorship, and the definition of art in the context of AI. Specifically, it examines theories such as:

- **The Romantic view of creativity**, which posits that artistic genius arises from the individual's deep emotional connection to the work (e.g., Schopenhauer's view of art as the expression of pure will).
- **The idea of creativity as a social construct**, as argued by thinkers like John Dewey, who saw creativity as a social process rather than an individual one.
- **AI as a new artistic medium**, as proposed by researchers like Elgammal et al. (2017), who argue that AI can be seen as another tool or medium, like painting or sculpture, through which artists can express their vision.

By using these theoretical frameworks, the paper aims to situate AI-generated art within broader debates about the essence of art and creativity. It asks whether AI art is a legitimate form of creative expression or simply a tool for enhancing human creativity.

Results and Discussion

Pre-AI Creativity in Painting

Historically, visual art was seen as a deeply human expression, shaped by the artist's individual perception, skill, and technique. Before the advent of digital tools,

painting was primarily a manual process. Artists like Leonardo da Vinci, Rembrandt, and Claude Monet were celebrated for their ability to capture reality through brushstrokes, color theory, and composition [8].

In XX century, movements like Abstract Expressionism and Surrealism pushed the boundaries of traditional art forms, often incorporating new tools such as photography or collage. However, even in these contexts, the artist's hand remained central to the creation of the artwork. Art was, and still is, a reflection of human experience, consciousness, and emotion.

The Emergence of AI in Art Creation

With the advent of AI, the creative landscape began to shift. AI tools like GANs (generative adversarial networks), neural networks, and machine learning algorithms allow machines to generate images based on vast datasets. Artists can now input their preferences and let AI generate new, often unpredictable, artworks. These systems do not simply mimic human creativity—they introduce novel ways of "thinking" and producing images that are sometimes indistinguishable from those created by humans.

In the context of visual arts, AI has enabled artists to experiment with new creative processes. For example, AI-generated art can explore styles ranging from hyper-realistic depictions to abstract designs, often with a complexity that would be difficult for the human eye to anticipate. As AI tools improve, they are capable of responding to specific aesthetic requests, helping artists produce work in new and innovative ways.

One famous example of AI's impact on the art world is the 2018 auction of an AI-generated painting, "Portrait of Edmond de Belamy," which sold for over $432,000 at Christie's Auction House. The portrait was created by the Paris-based art collective Obvious using a GAN. The painting generated considerable debate about the value and authorship of AI-generated art, with critics questioning whether AI art could be considered "true" art or whether it undermined human creativity.

Post-AI Creativity: Redefining Authorship and Creativity

Post-AI, the landscape of visual arts has expanded to include both traditional techniques and digital creations made with AI assistance. The notion of authorship is a key issue in this transition. Traditional art has been based on the idea that the artist is the creator—the individual responsible for the piece's form and meaning. However, with AI-generated art, the question arises: who owns the artwork—the artist who programmed the AI, the AI itself, or the audience that interprets it?

AI in the visual arts also raises questions about creativity itself. Some argue that AI is simply a tool that allows artists to experiment and push the boundaries of their work (Elgammal et al., 2017). Others, however, question whether an artwork created by an AI can be considered "creative" in the traditional sense. Is creativity simply the product of human intuition, or can an algorithm be creative by virtue of its ability to produce novel combinations of visual elements? While AI has provided artists with new possibilities, it has also raised concerns about the potential devaluation of human creativity. Critics argue that AI may lead to an oversaturation of artwork and a reduction in the appreciation of human-made art, potentially diminishing the status of painters and other traditional artists. Moreover, AI's involvement in art creation has sparked discussions about ethical considerations, including authorship, ownership, and the potential for AI to reproduce biased or harmful content based on its training data.

Conclusion

The impact of AI on visual arts is transformative, challenging established notions of creativity, authorship, and value. The pre-AI era saw art as a deeply human endeavor, with each brushstroke or photograph representing an artist's unique vision. With the rise of AI, artists now have access to powerful tools that offer new opportunities for exploration and experimentation. However, this shift has also brought new challenges, particularly concerning authorship and the ethics of AI-generated art. As AI technology continues to evolve, its role in the arts will likely grow, prompting further debate on the nature of creativity and the place of human artists in a world increasingly shaped by machine intelligence. It remains to be seen whether AI will ultimately augment human creativity or diminish it. Nevertheless, one thing is clear: the impact of AI on visual arts has only just begun, and its influence will continue to shape the future of artistic practice.

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BIOLOGICAL SCIENCES

FACTORS OF DIMORPHISM AND SUCCESSION IN HIGHER AQUATIC PLANTS

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Abstract

This article examines the factors of dimorphism and succession in higher aquatic plants, which determine their adaptation and development under changing aquatic conditions. Dimorphism is expressed through morphological and physiological differences between emergent and submerged plant organs, enabling the efficient use of light, oxygen, and nutrients. It develops under the influence of light availability, depth, water transparency, and chemical composition of the environment, and reflects phenotypic plasticity - the ability of plants to alter their form without genetic change. Succession refers to the sequential replacement of plant communities over time, beginning with pioneer species and progressing toward stable communities typical of marsh or terrestrial ecosystems. This process is driven by natural factors (climate, hydrology, biotic interactions) as well as anthropogenic influences (eutrophication, pollution, water-level regulation). The study concludes that while dimorphism ensures individual plant adaptation, succession reflects the evolutionary trajectory of the entire community. Together, these processes shape the resilience and dynamic balance of aquatic ecosystems.

Keywords: dimorphism, succession, heterophylly, cuticle, eutrophication

Introduction

Dimorphism and succession represent two fundamental biological phenomena that determine the structural-functional organization and dynamics of higher aquatic plant communities. These processes reflect the adaptive capacities of hydrophytes and macrophytes in changing aquatic environments, where fluctuations in water level, light intensity, chemical composition, and hydrodynamic factors play a decisive role [2,3,5,6].

Dimorphism in higher aquatic plants manifests as morphological and physiological differences between forms arising in response to distinct ecological conditions. The most common types of dimorphism include differences between submerged and emergent leaves (heterophylly), as well as between generative and vegetative shoots [7].

Materials and Methods

Research was conducted in aquatic ecosystems of different types - standing (ponds, lakes) and flowing (rivers, canals) - with the aim of identifying morpho-physiological differences and patterns of community turnover in higher aquatic plants. Fieldwork was carried out during the growing season (May–September). Plant samples were collected at depths from 0.1 to 2.5 m, taking into account gradients of light availability, trophic status, and flow velocity [1].

At each sampling site, physicochemical parameters of water were measured: temperature, transparency, pH, dissolved oxygen, and concentrations of biogenic elements (nitrates, phosphates) [4].

To assess dimorphism, differences between submerged and emergent shoots were analyzed, including internode length, leaf area, cuticle thickness, and fresh and dry biomass. Data were processed using methods of variational statistics.

Dimorphism is frequently observed in species of *Potamogeton*, *Ranunculus*, *Myriophyllum*, and *Sagittaria*. Such differences allow plants to optimize photosynthesis, gas exchange, and nutrient uptake depending on submergence level and light availability. For example, submerged leaves are usually thinner, more dissected, and poorer in mechanical tissues, increasing the surface area for CO_2 and mineral uptake. In contrast, emergent leaves possess a well-developed cuticle and stomata for transpiration regulation.

The development of dimorphism is closely associated with environmental factors. Light availability, depth, water transparency, and dissolved oxygen concentration directly influence morphological transformations. In eutrophic waterbodies characterized by high turbidity and low oxygen levels, plants predominantly form submerged leaves with an enlarged photosynthetic surface. In oligotrophic, clear waters, forms with pronounced emergent leaves prevail. Thus, dimorphism constitutes an expression of phenotypic plasticity - the ability of plants to modify morphological traits in response to external stimuli without genetic restructuring.

Succession of aquatic vegetation represents the process of sequential replacement of plant communities over time within a waterbody or its particular zone. This process may be directional or cyclical, reflecting ecosystem development from simple to more complex organizational states. Early successional stages are typically characterized by the appearance of pioneer species -filamentous algae, pondweeds, and *Elodea* species - that rapidly colonize open water. Over time, they create organic substrate and alter the physicochemical properties of water and sediments, preparing the environment for more stable communities.

During progressive succession, gradual accumulation of organic matter, reduction in depth, and decreased flow velocity promote the transition from hydrophytic to hygrophytic, and subsequently to meadow or marsh vegetation types. As a result, the waterbody gradually transforms into a marshy area and eventually into a terrestrial ecosystem. This process may take dec-

ades or even centuries and depends on climate, waterbody type, geomorphology, and anthropogenic impacts.

Biotic factors exert strong influence on successional processes. Competition for light and nutrients, as well as symbiotic and antagonistic interactions among plants, microalgae, and microorganisms, determine the stability of the phytocenosis. Animals - particularly invertebrates and fish - also play an important role by modifying sediment structure and dispersing seeds and plant fragments, thus accelerating or slowing succession.

Anthropogenic factors - including eutrophication, pollution, and hydrological regulation -can drastically alter the direction of succession. Excess input of nutrients (nitrogen, phosphorus) accelerates overgrowth of waterbodies, leading to biodiversity loss and disruption of ecosystem balance. Conversely, water-level regulation and channel clearing may slow natural processes and cause regressive succession, returning vegetation to earlier developmental stages.

Conclusion

Dimorphism and succession are interconnected phenomena that ensure the stability and adaptability of higher aquatic plants to changing environmental conditions. Dimorphism acts as a mechanism of rapid morphophysiological response at the level of the individual organism, whereas succession reflects long-term restructuring of the plant community. Their integrated study provides deeper insight into the functioning of aquatic ecosystems and informs the development of effective conservation and restoration strategies.

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CHEMICAL SCIENCES

THE PROCESSES OF CONJUGATED HETEROPHASE CHEMICAL CONVERSION OF SULFIDE COMPOUNDS OF Cu, Zn AND Fe UNDER CRE CONDITIONS WITH THE FORMATION OF ELEMENTAL SULFUR

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ПРОЦЕССЫ СОПРЯЖЕННОГО ГЕТЕРОФАЗНОГО ХИМИЧЕСКОГО ПРЕВРАЩЕНИЯ СУЛЬФИДНЫХ СОЕДИНЕНИЙ Cu, Zn И Fe В РЕЖИМЕ ВЦР С ОБРАЗОВАНИЕМ ЭЛЕМЕНТАРНОЙ СЕРЫ

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Abstract

It has been demonstrated that under the effect of a chain gas-phase hydrocarbon chlorination reaction (CRE mode) and at certain CRE-process parameters (Cl_2:RH, τ_k, T, t), an intensive conjugated heterophase conversion of copper sulfide concentrate (chalcopyrite $CuFeS_2$), iron disulfide in the form of pyrite concentrate (pyrite FeS_2), and zinc sulfide concentrate (sphalerite ZnS) occurs at significantly reduced temperatures. It has been established that the CRE-processing of all studied sulfides begins with the formation of elemental sulfur (S), after which the formation of anhydrous chlorides of the corresponding metals ($FeCl_3$, $CuCl_2$, $ZnCl_2$) takes place. At the process temperatures, these chlorides sublime into the gas phase and are removed from the reactor by the flow of reacting

gases. The formation and removal from the reaction zone of the products of the heterophase conjugated process (which are themselves valuable) occur separately (selectively and directionally) – both physically and temporally.

Аннотация

Показано, что в условиях воздействия цепной газофазной реакции хлорирования углеводородов (режим ВЦР) и при определенных параметрах ВЦР-процесса (Cl_2:RH, $\tau_к$, T, t) имеет место интенсивное сопряженное превращение медного сульфидного концентрата (халькопирит $CuFeS_2$), дисульфида железа в виде пиритового концентрата (железный колчедан FeS_2) и сульфидного цинкового концентрата (сфалерит ZnS) при существенно пониженных температурах. Установлено, что процесс ВЦР-переработки всех изученных сульфидов начинается с образования элементарной серы (S), после завершения чего происходит образование безводных хлоридов соответствующих металлов ($FeCl_3$, $CuCl_2$, $ZnCl_2$), которые при температурах процесса сублимируют в газовую фазу и выводятся из реактора потоком реагирующих газов. Образование и вынос из реакционного узла (уже самих по себе ценных) продуктов гетерофазного сопряженного процесса происходит раздельно (селективно-направленно) – и физически, и во времени.

Keywords: sulfide compounds, heterophase chemical conversion, elemental suulfur.

Ключевые слова: сульфидные соединения, гетерофазное химическое превращение, элементарная сера.

Введение

Проблемы переработки сульфидов различных металлов, повышение эффективности этих процессов и усовершенствование существующих технологий, по-прежнему остаются актуальными. На этих важных процессах базируются промышленные производства таких металлов, как медь (Cu), молибден (Mo), железо (Fe), цинк (Zn), рений (Re) и др. Как известно, в промышленности, в частности в металлургических процессах, широко применяется метод обработки сульфидов металлов путем их окисления (т.н. ”окислительный обжиг”). Этот подход применяется практически для сульфидов всех металлов. В результате использования этого способа, сера (S), содержащаяся в сульфидах, удаляется в виде сернистого газа (SO_2) с получением оксида соответствующего металла или смеси оксидов металлов. Далее, при данной обработке используются методы разделения и восстановления металлов из оксидов, обычно применяемые в металлургических процессах [1-3]. Восстановление сульфидов металлов здесь осуществляют молекулярным водородом, монооксидом углерода или их смесью, а также углеродом [4,5]. Однако, все эти процессы очень энергоемкие, протекают при повышенных температурах, экологически не выгодны, а их реализация связана с проблемами эксплуатации сложного технологического оборудования в условиях высоких температур. Существующие традиционные методы ”хлоридовозгонки”, применяемые для превращения металлов в хлориды и извлечения их из природного сырья, различных соединений и материалов, как правило, также осуществляются при повышенных температурах, часто в расплавах с добавками хлорсодержащих соединений и материалов [6-8]. Применяются также методы брикетирования сырья с твердофазным восстановителем и последующим воздействием газообразным хлором [9, 10]. Эти процессы также протекают при повышенных температурах. Наряду с этими высокотемпературными методами существуют также методы воздействия кислотами [11], что неизбежно приводит, в частности к трудно-разрешимым экологическим проблемам, связанных с кислотосодержащими отходами.

Однако, применение принципиально нового научного подхода: осуществление гетерофазных химических превращений твердофазных неорганических соединений и материалов под воздействием цепных газофазных реакций (ВЦР-процессы) [12-18] – открывает новые возможности для разработки эффективных современных процессов переработки сульфидных материалов различных металлов методом ВЦР [19-21]. Важной особенностью этого подхода является то, что под воздействием цепных газофазных реакций, гетерофазные превращения такого типа протекают с высокой скоростью и при существенно пониженных температурах по сравнению с традиционными методами осуществления химических превращений газ – твердая фаза.

Постановка задачи

Осуществлены целевые исследования, которые были направлены на разработку процессов гетерофазного химического превращения, имеющихся в Армении различного типа сульфидных рудных концентратов, с образованием элементарной серы, в условиях применения ВЦР-способа [12-18]. Ставилась задача, исследовать, выявить и развить количественно-качественные закономерности и физико-химические особенности такого типа радикально-цепных процессов – для создания в ближайшей перспективе научных и инженерно-технологических основ высокоэффективных новых химических и металлургических процессов переработки различного металлического минерального рудного сырья Республики Армения.

Методика эксперимента

Эксперименты проводились в проточном режиме осуществления цепной газофазной реакции хлорирования углеводородов RH (метана (CH_4) и пропан-*н*-бутановой смеси (C_3H_8+C_4H_{10})) с хлором (Cl_2) следующего объемного состава Cl_2:RH=(8÷10):1. Цепная реакция протекала в *квази*-стационарном режиме, в кварцевом цилиндрическом реакторе (d=40 *мм*, l_1=70 и l_2=300 мм), обогреваемом терморегулируемой электропечью (Рис. 1). Время контакта варьировалось в пределах $\tau_к$= от 9 до 25 *с*. Образцы с сульфидами металлов помещались в реактор в кварцевой лодочке. Про-

дукты реакции, выносимые из реактора газовым потоком, конденсировались в ловушках, помещенных на выходе из реактора. Потоки газов регулировались с помощью реометров и смешивались в шарообразном стеклянном смесителе до входа в реактор. Экспериментальная методика и принципы работы кинетической лабораторной установки более подробно описаны в [16, 18, 21]. В качестве исходных сульфидов использовались: 1) медный сульфидный концентрат ($CuFeS_2$) – халькопирит Каджаранского месторождения Армении следующего химического состава (содержание компонентов *%*, масс.): Cu – 17,92 *%*, S – 33,04 *%*, SiO_2 – 9,02 *%*, Fe – 20,73 *%*, Al_2O_3 – 5,38 *%*, CaO – 1,89 *%*, MgO – 2,73 *%*, Zn – 1,73 *%*, Pb – 0,29 *%*, As – 0,40 *%*, Ag – $1{,}66 \cdot 10^{-4}$ *%*, Au – $28{,}73 \cdot 10^{-4}$ *%*; 2) сульфидный цинковый концентрат (ZnS, сфалерит) с химическим элементным составом (*%*, *масс*): Zn – 51,00 *%*, Pb – 3,00 *%*, As – 2,50 *%*, S – 31,50 *%*, нерастворимый осадок – 6,60 *%*, остальное – разные примеси; 3) дисульфид железа в виде пиритового концентрата (FeS_2, железный колчедан) с примесью станина ($CuS \cdot FeS \cdot SnS_2$, оловянный колчедан) в пропорции: $FeS_2 \approx 70$ *%* и $CuS \cdot FeS \cdot SnS_2 \approx 30$ *%*.

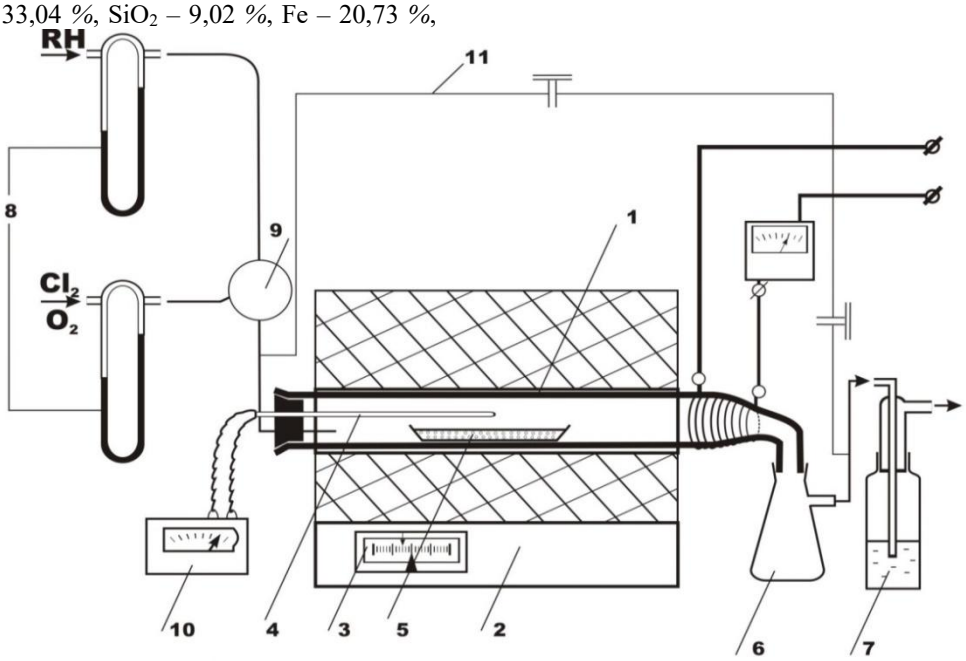

Рис. 1. Схема кинетической экспериментальной лабораторной установки: 1 - реактор, 2 – электропечь, 3 – терморегулятор, 4 – термопара, 5 – кварцевая лодка, 6 – ловушка, 7 – барбатер, 8 – реометры подачи газовых реагентов, 9 – газовый смеситель, 10 – потенциометр, 11 – байпасная линия.

Результаты и их обсуждение

В частности показано, что в условиях воздействия цепной газофазной реакции хлорирования углеводородов и при определенных параметрах ВЦР-процесса (Cl_2:RH, $\tau_к$, T, t) имеет место интенсивное сопряженное превращение медного сульфидного концентрата (халькопирит $CuFeS_2$), дисульфида железа в виде пиритового концентрата (железный колчедан FeS_2) и сульфидного цинкового концентрата (сфалерит ZnS) при существенно пониженных температурах. Установлено, что процесс ВЦР-переработки всех изученных сульфидов начинается с образования элементарной серы (S), после завершения чего происходит образование безводных хлоридов соответствующих металлов ($FeCl_3$, $CuCl_2$, $ZnCl_2$), которые при температурах процесса сублимируют в газовую фазу и выводятся из реактора потоком реагирующих газов. Образование и вынос из реакционного узла (уже самих по себе ценных) продуктов гетерофазного сопряженного процесса происходит раздельно (селективно-направленно) – и физически, и во времени. Такая переработка позволяет избежать высокотемпературные, энергоемкие процессы плавки, которые применяются в традиционной металлургии, а также исключить стадию обжига, где сера удаляется в виде SO_2-газа и неизбежно попадает в окружающую среду. Исследования в целом показывают, что при применении принципиально нового метода ВЦР-воздействия сульфидные концентраты меди, железа и цинка подвергаются эффективной переработке с высокими скоростями химического превращения. Продукты превращения сульфидов Cu, Zn и Fe, полученные в режиме ВЦР ($CuCl_2$, $ZnCl_2$, $FeCl_3$), могут быть также, тем же ВЦР-методом, восстановлены вплоть до высококачественного порошкообразного металлического состояния, с необходимыми свойствами. При этом, каждый из основных твердофазных продуктов ВЦР-переработки – элементарная сера и хлориды металлов имеют самостоятельное применение. В таблице приводятся некоторые принципиальные данные и параметры изученных ВЦР-процессов.

Таблица

Исходное сульфидное соединение	Соотношение Cl_2:RH	Температура процесса °C	Синтезируемые целевые продукты
$CuFeS_2$	(8÷10):1	450÷800	S, безводные $FeCl_3$ и $CuCl_2$
FeS_2	(9÷10):1	≈300	S и безводный $FeCl_3$
ZnS	(9÷10):1	360÷430	S и безводный $ZnCl_2$

Для наглядности на рисунке 2 приводятся фотографии твердофазных продуктов гетерофазного химического превращения медного сульфидного концентрата (халькопирит $CuFeS_2$) под воздействием цепной газофазной реакции хлорирования углеводородов.

a) b) c) d)

Рис. 2. Основные целевые твердофазные продукты гетерофазного превращения медного сульфидного концентрата (халькопирит $CuFeS_2$) под воздействием цепной газофазной реакции хлорирования углеводородов: a) исходный образец медного сульфидного концентрата; b) порошкообразная элементарная сера (S), полученная в результате ВЦР-превращения; c) безводный трихлорид железа ($FeCl_3$), синтезированный в ВЦР-режиме; d) безводный дихлорид меди ($CuCl_2$), полученный в результате ВЦР-превращения.

Выводы

Таким образом, выявлено, что характерной особенностью для всех изученных сульфидов является их интенсивное ВЦР-превращение с выделением элементарной серы в парообразном состоянии, выносимой газовым потоком из реактора. ВЦР-процесс начинается с образования газообразной S, а спустя определенное время, из реактора потоком газов выносятся хлориды соответствующих металлов, которые при температурах осуществления процесса сублимируют в газовую фазу. При этом, в ходе сопряженного гетерофазного ВЦР-превращения эти компоненты четко разделяются физически и во времени, а затем селективно-последовательно поступают в приемники-ловушки. Полученные результаты выдвигают необходимость подробного кинетического исследования этих новых гетерофазных процессов химического превращения. В случае применения на практике и дальнейшего развития, они могут стать основой для создания эффективных химических и металлургических процессов и технологий комплексной переработки сульфидных рудных концентратов и соединений с образованием элементарной серы и других ценных продуктов, заменяя энергоемкие, высокотемпературные, многостадийные и экологически небезопасные традиционные способы, которые применяются в промышленности Республики Армения.

Представленные результаты исследований осуществлены в рамках научных направлений, финансируемых по базовому принципу Комитетом по Высшему Образованию и Науке при Министерстве ОНКС Республики Армения.

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EARTH SCIENCES

CLIMATE CHANGE AS A DETERMINANT OF HUMAN HEALTH: EMERGING CHALLENGES AND ADAPTATION STRATEGIES

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Abstract
Climate change has emerged as one of the most critical determinants of human health in the 21st century. Rising global temperatures, changes in precipitation patterns, and an increase in the frequency of extreme weather events have created new health challenges that transcend geographical and socio-economic boundaries. This paper explores the multidimensional pathways through which climate change affects physical, mental, and social health, emphasizing the need for adaptive and preventive health strategies at both global and local scales.

Keywords: climate change, public health, adaptation, resilience, environmental risks

Introduction: Climate change represents a profound environmental transformation that directly and indirectly influences human well-being. The continuous rise in atmospheric greenhouse gases has intensified the global energy balance, leading to prolonged heatwaves, altered rainfall regimes, and the degradation of ecosystems that sustain human life. The World Health Organization (WHO) recognizes climate change as a defining health challenge of our time, estimating that between 2030 and 2050, it could cause approximately 250,000 additional deaths annually due to heat stress, malnutrition, malaria, and diarrhea. The issue is no longer confined to environmental science—it has become a central concern of global health and sustainable development.

Direct Health Impacts of Climate Change: Direct health effects arise primarily from extreme weather events such as heatwaves, floods, hurricanes, and wildfires.

Heat-related illnesses	Increased temperature and humidity levels intensify the risk of heat exhaustion, particularly among elderly populations and urban residents.
Injury and mortality	Floods and storms cause physical trauma, displacements, and disruptions of healthcare services
Air quality degradation	Rising temperatures exacerbate air pollution and ground-level ozone formation

These direct effects are typically acute, but their cumulative impact on mortality and morbidity is substantial.

Indirect Health Impacts: The indirect pathways of impact are more complex and long-term in nature.

- **Vector-borne diseases:** Warmer climates expand the habitats of mosquitoes and ticks, increasing the prevalence of diseases such as malaria, dengue fever, Zika, and Lyme disease.
- **Water- and food-borne illnesses:** Higher temperatures and erratic rainfall promote the growth of pathogens in water and soil, leading to outbreaks of cholera, dysentery, and salmonellosis.
- **Food security:** Crop failure due to droughts, soil salinization, and changing precipitation patterns threatens nutritional health, particularly in low-income regions.
- **Mental health impacts:** Climate-induced disasters often lead to psychological distress, depression, anxiety, and post-traumatic stress disorder (PTSD).

Social and Economic Dimensions: Climate change magnifies social inequalities. Vulnerable populations — including children, the elderly, rural communities, and low-income households — face disproportionate risks.

Economic instability caused by reduced agricultural productivity, job losses, and forced migration exacerbates poverty and limits access to healthcare. This intersection between environmental stress and socio-economic vulnerability creates a **health inequity loop**, where the poorest populations bear the heaviest burden

despite contributing the least to greenhouse gas emissions.

Adaptation and Mitigation Strategies: To safeguard public health, adaptation strategies must

be integrated into broader climate and development policies.

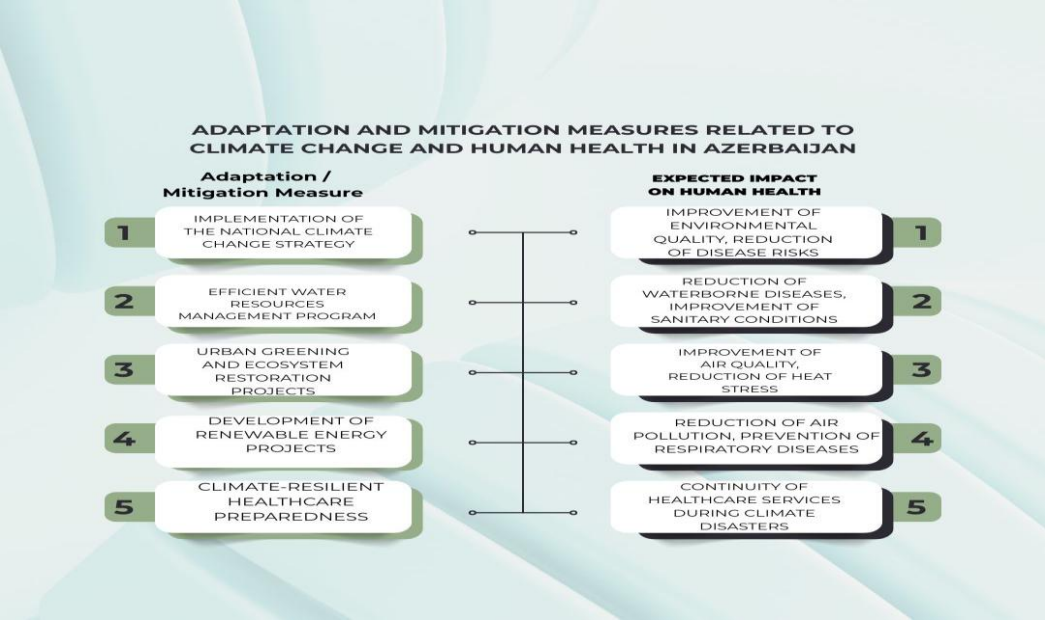
Key approaches include:

1. **Strengthening health systems:** Develop climate-resilient healthcare infrastructure capable of responding to emergencies and heat-related illnesses.
2. **Early warning and surveillance:** Establish monitoring networks for climate-sensitive diseases and extreme weather events.
3. **Public education:** Enhance community awareness on climate-health interactions and promote preventive behaviors.
4. **Sustainable urban planning:** Expand green spaces, improve ventilation, and implement heat-reducing architectural designs.
5. **Global cooperation:** Promote equitable climate financing and technology transfer to support developing nations in building adaptive capacity.

Climate change represents a complex and multifaceted threat to human health. Extreme weather events, fluctuations in temperature, pollution of air and water, disruptions in food security, and the spread of vector-borne diseases all significantly affect the quality of life. These impacts extend beyond physical health, also posing risks to mental and psychosocial well-being. Furthermore, climate change exacerbates economic and social inequalities, leaving vulnerable populations particularly exposed to its consequences.

Table 1.

Adaptation and Mitigation Measures Related to Climate Change and Human Health in Azerbaijan


ADAPTATION AND MITIGATION MEASURES RELATED TO CLIMATE CHANGE AND HUMAN HEALTH IN AZERBAIJAN
Adaptation / Mitigation Measure
EXPECTED IMPACT ON HUMAN HEALTH
1
IMPLEMENTATION OF THE NATIONAL CLIMATE CHANGE STRATEGY
IMPROVEMENT OF ENVIRONMENTAL QUALITY, REDUCTION OF DISEASE RISKS
1
2
EFFICIENT WATER RESOURCES MANAGEMENT PROGRAM
REDUCTION OF WATERBORNE DISEASES, IMPROVEMENT OF SANITARY CONDITIONS
2
3
URBAN GREENING AND ECOSYSTEM RESTORATION PROJECTS
IMPROVEMENT OF AIR QUALITY, REDUCTION OF HEAT STRESS
3
4
DEVELOPMENT OF RENEWABLE ENERGY PROJECTS
REDUCTION OF AIR POLLUTION, PREVENTION OF RESPIRATORY DISEASES
4
5
CLIMATE-RESILIENT HEALTHCARE PREPAREDNESS
CONTINUITY OF HEALTHCARE SERVICES DURING CLIMATE DISASTERS
5

Discussion: The relationship between climate change and human health is dynamic and interconnected. Adaptation without mitigation merely delays the impacts, while mitigation without adaptation fails to address current vulnerabilities. Therefore, a **comprehensive, interdisciplinary approach** that unites climate science, epidemiology, urban planning, and social policy is essential. Furthermore, health data systems must evolve to track climate-sensitive outcomes, enabling policymakers to make evidence-based decisions.

Conclusion: Climate change is not only an environmental or economic issue — it is fundamentally a health issue. Protecting human health in a changing climate requires long-term commitment, intersectoral collaboration, and equitable policies that prioritize the most vulnerable populations. By aligning health adaptation strategies with climate action, humanity can build resilience and ensure that future generations inherit not only a livable planet but also a healthier one.

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ECONOMIC SCIENCES

UNEXPLORED QUESTIONS IN APPLYING THE GRAVITY MODEL TO KAZAKHSTAN'S TRADE: TOWARD A FUTURE RESEARCH AND POLICY AGENDA

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Abstract

The Gravity Model of International Trade has been widely applied to analyze Kazakhstan's bilateral trade flows, offering critical insights into the influence of economic size, geographic distance, institutional arrangements, and trade facilitation. While existing research addresses important areas—such as the Eurasian Economic Union (EAEU), Kazakhstan's WTO accession, and trade facilitation—significant gaps remain regarding geopolitical shocks, digital trade, and firm-level heterogeneity. This paper synthesizes the current evidence and identifies three major yet under-explored research questions with substantial implications for policy and future scholarship. These include the trade effects of the Russia–Ukraine war and sanctions on Russia; the role of digital infrastructure in reducing trade costs; and the differing responsiveness of large firms and SMEs to trade costs through firm-heterogeneity-extended gravity models. For each question, the paper outlines its importance, theoretical grounding, methodological pathways, and expected empirical outcomes. The study concludes by proposing a forward-looking research agenda to guide Kazakhstan toward diversification, digitalization, and sustainable integration into global markets.

Keywords: Gravity Model, Bilateral Trade, Eurasian Economic Union (EAEU), Trade Facilitation, Kazakhstan.

1. Introduction

Kazakhstan's strategic geographic position—bridging Europe and Asia—and its abundant natural resources have long placed it at the center of discussions on Eurasian economic integration (Alimzhanova, 2015; Choi et al., 2019). As a landlocked yet globally connected economy, Kazakhstan provides a compelling case for applying the Gravity Model of International Trade, which predicts bilateral trade flows based on economic size, geographic distance, and other structural factors. Empirical studies consistently confirm that Kazakhstan's trade patterns are heavily influenced by partner-country GDP, transport and transaction costs associated with distance, and longstanding post-Soviet historical and cultural linkages (Felipe & Kumar, 2012). In addition, trade facilitation measures and institutional arrangements—most notably Kazakhstan's membership in the Eurasian Economic Union (EAEU) and its active participation in China's Belt and Road Initiative (BRI)—have further shaped its trade orientation, logistics corridors, and market access conditions (Nurseit, 2014; Herman & Oliver, 2023).

Despite the contributions of this growing literature, several important analytical domains remain underexplored. The country's trade environment has undergone significant transformation driven by recent geopolitical disruptions, including sanctions dynamics in the wider Eurasian region, shifts in global supply chains, and the reconfiguration of transit routes (Tauhen, 2012; Deming & Ross, 2023). At the same time, rapid digitalization, the modernization of customs procedures, and the expansion of e-commerce platforms have altered the mechanisms through which cross-border trade occurs—developments that traditional gravity formulations only partially capture. Another critical yet understudied dimension is Kazakhstan's structural dualism: while the economy is dominated by a few large resource-based firms, a substantial segment of small and medium-sized enterprises (SMEs) struggles to integrate into regional and global markets. This imbalance creates heterogeneous trade responses across sectors, suggesting that aggregate gravity estimates may mask important micro-level disparities.

Addressing these gaps is essential for designing evidence-based trade policies that can strengthen Kazakhstan's global competitiveness and support its long-term goal of economic diversification beyond hydrocarbons. A more nuanced application of the gravity framework—one that incorporates technological change, geopolitical uncertainty, and sector-level asymmetries—offers significant potential for producing richer insights into Kazakhstan's evolving trade structure.

Against this backdrop, this paper identifies and develops three major research questions that remain insufficiently examined in the context of Kazakhstan's international trade. Drawing on theoretical extensions of the gravity model, comparable empirical evidence from other emerging economies, and Kazakhstan-specific structural characteristics, the study offers a conceptual foundation for future empirical investigations.

The questions raised are intended to guide a new research agenda that reflects both the complexities of Kazakhstan's economic landscape and the broader transformations shaping global trade.

2. Literature Review

Research applying the Gravity Model to Kazakhstan has grown steadily over the past two decades, reflecting the country's evolving trade structure and its integration into global and regional markets. Much of this work focuses on classical determinants of bilateral trade flows and the impact of regional economic frameworks. The existing literature can be clustered into four major thematic areas.

2.1 Bilateral Trade Determinants

A substantial body of empirical research examines Kazakhstan's bilateral trade flows using traditional gravity variables such as economic mass and geographic distance(Felipe & Kumar, 2012; Alimzhanova, 2015). These studies consistently demonstrate that Kazakhstan's trade is positively associated with both its own GDP growth and the economic size of its partner countries, reflecting resource-driven export capacity and demand conditions in external markets. Distance generally exerts a negative influence, although several authors note that this effect is sometimes attenuated due to Kazakhstan's landlocked position and the limited development of its transport corridors. Some scholars argue that the implicit costs embedded in weak logistics networks generate nonlinear or asymmetrical distance effects, making physical distance a less reliable proxy for trade costs in Kazakhstan than in more connected economies.

Historical and cultural linkages also play a prominent role. Research repeatedly finds that post-Soviet ties—shared administrative norms, linguistic proximity, and legacy supply-chain relationships—significantly increase Kazakhstan's trade intensity with CIS countries. These path-dependent patterns have proven remarkably persistent, influencing not only trade volumes but also the composition of Kazakhstan's trade basket.

2.2 Regional Integration and WTO Accession

The literature on regional integration emphasizes Kazakhstan's participation in the Eurasian Economic Union (EAEU) and its earlier accession to the Customs Union with Russia and Belarus (Tauhen, 2012). Gravity-based assessments suggest substantial import-side trade creation, particularly in manufactured goods, as tariff barriers declined and customs procedures were harmonized. However, findings regarding export-side effects are mixed. Several studies highlight constraints related to Kazakhstan's narrow export structure, dominated by primary commodities, which limits opportunities for intra-industry trade within the EAEU (Khatibi, 2008).

Complementary research analyzing Kazakhstan's accession to the World Trade Organization (WTO) uses gravity simulations to estimate the potential gains from tariff liberalization, improved transparency, and regulatory alignment. These studies generally predict increased trade flows, especially with non-EAEU partners, driven by institutional reforms and reductions in non-tariff barriers. Nonetheless, the actual post-accession trajectory remains uneven, pointing to lingering structural rigidities that complicate the translation of institutional reforms into trade expansion.

2.3 Trade Facilitation

A growing literature highlights the critical role of trade facilitation in shaping Kazakhstan's external trade performance. Studies drawing on indices such as the Logistics Performance Index (LPI), Doing Business indicators, and customs efficiency measures find strong positive effects of improved border management, transport infrastructure, and transparency on trade volumes (Felipe & KUmar, 2012). Estimates vary, but sectoral analyses suggest that enhanced logistics and reduced border delays could increase Kazakhstan's exports by 5–25%, with the largest gains concentrated in manufacturing, agro-processing, and time-sensitive goods.

Research in this area also underscores the interaction between soft infrastructure (customs procedures, governance quality, digital documentation) and hard infrastructure (railways, transit hubs, and road networks). Kazakhstan's position as a major transit country within the Belt and Road Initiative (BRI) amplifies the importance of these facilitation measures, as small improvements in efficiency can have disproportionately large effects on transit flows and corridor competitiveness.

2.4 Trade with China and Spatial Gravity Models

A more recent stream of studies applies spatial and subnational extensions of the gravity model to Kazakhstan's trade with China. These analyses incorporate variables such as relative distance across different transport corridors, the development of special economic and cross-border cooperation zones (e.g., Khorgos), and the fragmentation of supply chains along the China–Central Asia–Europe route (Choi et al., 2019). Findings indicate that spatial interdependencies significantly shape trade flows: regions closer to major border crossings exhibit stronger export responsiveness, while hinterland regions face persistent structural disadvantages.

These models also highlight the importance of accounting for spatial spillovers, as infrastructure upgrades or policy interventions in one region can influence trade performance in neighboring areas. This emerging literature demonstrates the limitations of aggregate gravity models that treat Kazakhstan as a geographically homogenous entity, underscoring the need for finer-grained analysis.

2.5 Gaps in the Existing Literature

Despite the progress across these thematic areas, several transformative forces remain insufficiently analyzed. First, the geopolitical realignments following 2022—including sanctions dynamics, new transit route configurations, and shifting trade partnerships—have not yet been systematically incorporated into gravity-based analyses of Kazakhstan. Second, the rapid growth of digital trade, e-commerce platforms, and paperless customs processes raises questions about how digitalization alters traditional determinants of trade costs (Herman & Oliver, 2023). Finally, firm-level heterogeneity is largely overlooked; most studies rely on

aggregate trade flows despite Kazakhstan's structural dualism between large resource exporters and a fragmented SME sector (Deming & Ross, 2023; Kee, 2012). Understanding how different types of firms respond to trade policy, logistics constraints, and global shocks represents a key frontier for future research.

3. Emerging and Unexplored Research Questions

3.1. How Have the Russia–Ukraine War and Western Sanctions on Russia Altered Kazakhstan's Trade Patterns?

Kazakhstan's economy is deeply interconnected with Russia through the EAEU and shared supply chains (Bourgeois & Rodgers, 2023). Western sanctions have reshaped regional flows and created new transit, diversion, and compliance pressures. Yet no gravity-based study quantifies these impacts. A dynamic gravity model incorporating sanction indices would likely show trade diversion toward China (+15–25%) through rerouted commodities and transport corridors. Second, it would indicate new trade creation with the EU facilitated by Middle Corridor initiatives. Third, such a model would indicate moderate declines in trade with Russia (−5–10%) in non-energy goods). Third, a gravity model would show short-term gains in Kazakhstan's economy through transit fees and rerouting (GDP +1–2%) but long-term risks from heightened regulatory and political uncertainty. This work would draw on Anderson-van Wincoop multilateral resistance terms and staggered-treatment difference-in-differences models used in sanction-related gravity studies.

3.2. How Do Digital Infrastructure Investments Affect Kazakhstan's Trade Costs and Digital Trade Potential?

Kazakhstan's Digital Kazakhstan 2025 strategy aims to expand broadband access, e-commerce platforms, and cross-border digital integration. Gravity models have not yet captured how digital connectivity mitigates distance and reduces transaction costs.

Digital-augmented gravity models suggest that digital connectivity lowers effective trade costs and strengthens SME participation (Herman & Oliver, 2023). It would also lead to equivalent reduction in the "distance penalty" of roughly 500 km, and a 10–15% growth in digital services exports to Asia-Pacific markets. Additionally, there would be stronger effects for SMEs, supporting inclusive growth. The theoretical basis for this argument is the ICT-augmented trade cost functions (Eaton–Kortum) and interaction models between digital indicators and distance.

3.3. How Do Large Firms and SMEs in Kazakhstan Respond Differently to Trade Costs?

Kazakhstan exhibits a dual economy where highly productive large firms dominate resource exports, while SMEs face significant barriers to exporting. This requires Melitz-style heterogeneous-firm gravity models to differentiate large exporters from SMEs (Deming & Ross, 2023; Kee, 2012). Traditional aggregate gravity models mask these differences.

It is expected that using Melitz-style gravity extensions would reveal that large firms exhibit lower sensitivity to trade costs (elasticity 0.6–0.8), and that SMEs exhibit much higher sensitivity (elasticity 1.5–2.0), especially to NTBs. It would also likely reveal that SMEs' limited productivity and compliance capacities restrict export entry, and that policies to raise SME productivity thresholds (innovation subsidies, logistics support) could expand exports by 8–12%.

4.Methodology

To address the emerging research questions and capture the evolving dynamics of Kazakhstan's international trade, this study proposes several methodological extensions to the traditional Gravity Model. These approaches reflect advances in empirical trade modeling and are well suited for analyzing geopolitical disruptions, digitalization, and firm-level heterogeneity—factors increasingly relevant for Kazakhstan's trade environment.

4.1. Dynamic Gravity Models with Time-Varying Sanction and Geopolitical Indicators

Traditional cross-sectional or static panel gravity models are limited in their ability to capture the effects of sudden geopolitical shocks, such as the post-2022 reconfiguration of Eurasian trade routes and sanction-induced supply chain disruptions. Dynamic gravity models, incorporating lagged trade flows and time-varying political or sanction indicators, offer a more suitable framework for examining adjustment processes over time (Bourgeois & Rogers, 2023).

Researchers can employ models such as the dynamic panel Generalized Method of Moments (GMM), which allows for persistence in trade flows and mitigates endogeneity between sanctions and trade outcomes. Time-varying indicators may include:

- bilateral sanctions intensity,
- shifts in transit corridor accessibility,
- political risk indices,
- changes in customs regimes or border closures.

By incorporating these variables, dynamic gravity models can estimate both immediate (short-run) and cumulative (long-run) effects of geopolitical shocks, providing insights into how Kazakhstan adapts to external constraints and opportunities.

4.2 ICT-Augmented Gravity Models Incorporating Digital Connectivity and Regulatory Quality

As Kazakhstan expands its digital infrastructure, digital trade and e-commerce increasingly shape bilateral trade patterns. Traditional gravity models using physical distance as a proxy for trade costs fail to capture the role of digital connectivity in reducing information frictions, lowering search costs, and facilitating market entry for SMEs.

ICT-augmented gravity models integrate variables such as:

- internet penetration rates,
- digital trade facilitation indices,
- adoption of electronic customs systems,
- cross-border digital payment capabilities,
- regulatory quality indicators related to digital markets.

These models may draw on Digital Trade Restrictiveness Index (DTRI) data or use composite indices

capturing digital readiness (Herman & Oliver, 2023). Incorporating these measures allows researchers to estimate how improvements in digital infrastructure alter Kazakhstan's effective trade costs and whether digitalization offsets some of the disadvantages associated with physical distance and landlockedness.

Advanced econometric specifications, such as PPML (Poisson Pseudo Maximum Likelihood), can be used to address heteroscedasticity and the presence of zero trade flows, which are common in digital and services trade data.

4.3 Melitz-Style Firm-Heterogeneity Gravity Models

Kazakhstan's dual economic structure—dominated by large multinational resource firms and supplemented by a heterogeneous SME sector—necessitates analytical approaches that go beyond representative-firm assumptions. Melitz-style gravity models, grounded in heterogeneous firm trade theory, allow for explicit differentiation between firms based on productivity levels, export capacity, and sensitivity to trade costs (Deming & Ross, 2023; Kee, 2012).

Firm-level gravity frameworks can incorporate:

- productivity distributions of exporters,
- extensive-margin responses (entry/exit into export markets),
- firm size, ownership structure, and investment capacity,
- exposure to non-tariff barriers (NTBs),
- sector-level variations in trade costs.

Such models can be estimated using customs microdata or enterprise surveys where available. They capture nonlinear and asymmetric responses to policy reforms—demonstrating, for example, how reductions in NTBs may benefit SMEs disproportionately relative to large firms, or how resource-sector dominance shapes aggregate trade elasticity estimates.

This approach is particularly relevant for Kazakhstan, where aggregate trade flows may mask significant micro-level dynamics relating to diversification efforts.

4.4 Analytical Value of the Proposed Approaches

Together, these methodological extensions enable researchers to:

- model **structural changes** arising from geopolitical and institutional shocks;
- capture **nonlinear and time-dependent responses** to evolving trade costs;
- differentiate **firm-level heterogeneity**, especially between dominant resource firms and vulnerable SMEs;
- integrate **digital and regulatory dimensions** of modern trade.

These tools provide a richer empirical strategy capable of informing policy debates on Kazakhstan's competitiveness, diversification, and long-term integration into global markets.

5. Discussion

The identified research gaps reveal a growing divergence between Kazakhstan's rapidly transforming trade environment and the analytical dimensions captured in the existing gravity literature. While traditional models have been useful in explaining past trade patterns, they offer limited insight into the new realities shaped by geopolitical, technological, and structural shifts. Addressing these shortcomings is essential for developing a more comprehensive understanding of Kazakhstan's evolving position in global markets.

First, the recent geopolitical realignment across Eurasia has profoundly altered Kazakhstan's trade incentives, logistic corridors, and strategic partnerships. The re-routing of supply chains, the emergence of new transit hubs, and shifting patterns of sanctions exposure all contribute to a trade environment characterized by heightened uncertainty and path dependence. Existing gravity studies, largely estimated on pre-2022 data or static institutional assumptions, cannot fully capture the speed and magnitude of these changes. Incorporating time-sensitive geopolitical indicators into dynamic gravity frameworks would enable researchers to evaluate Kazakhstan's repositioning within Eurasian trade networks and identify the durability of new trade routes and market opportunities.

Second, digital transformation has introduced new channels through which Kazakhstan can mitigate traditional disadvantages linked to land-lockedness and long-distance markets. The rapid expansion of e-commerce platforms, improvements in customs digitalization, and integration of cross-border payment systems have begun to reshape trade costs in ways not reflected in classical gravity variables. ICT-augmented gravity models would allow for a systematic assessment of how digital infrastructure functions as a partial substitute for geographic constraints, reducing search costs, improving market matching, and enabling SMEs to reach foreign consumers more directly. Understanding these mechanisms is especially relevant as Kazakhstan pursues a broader strategy of digital modernization and innovation-led growth.

Third, the structure of Kazakhstan's economy—marked by the coexistence of dominant resource-based multinationals and a fragmented SME sector—produces heterogeneous responses to policy reforms and global shocks. Aggregate gravity models mask these micro-level variations, obscuring the nuances of market entry decisions, export upgrading, and the distributional impacts of trade liberalization. Melitz-style firm-heterogeneity gravity models offer a path toward capturing these differentiated behaviors. By distinguishing between firm types, such models can illuminate how targeted policies—such as SME export promotion, NTB reduction, or logistics support—affect diversification, value chain integration, and competitiveness at the sectoral and firm levels.

Together, these methodological directions contribute to a more realistic, granular, and actionable understanding of Kazakhstan's trade potential in a rapidly changing economic landscape. They allow researchers and policymakers to move beyond traditional assumptions and incorporate the complex interplay of geopolitics, digitalization, and firm-level dynamics into trade analysis. By expanding the analytical toolkit, future studies can better inform national strategies aimed at strengthening resilience, promoting diversification, and enhancing Kazakhstan's role within regional and global economic systems.

6. Conclusion

Kazakhstan's trade environment is undergoing a period of profound and unprecedented transformation. Geopolitical re-configurations across Eurasia, rapid advances in digital technologies, and the country's own internal economic dualism are simultaneously reshaping the determinants, channels, and composition of its international trade. While the Gravity Model has provided a robust framework for examining Kazakhstan's past trade patterns, the existing literature has yet to fully capture these emerging dynamics. As a result, significant conceptual and empirical gaps remain, limiting policymakers' ability to craft strategic responses to the country's evolving trade challenges and opportunities.

This paper has highlighted three broad areas where further research is urgently needed: the incorporation of geopolitical shocks and time-sensitive political variables; the integration of digital connectivity and regulatory quality into gravity-based assessments; and the differentiation of firm-level behavior in a structurally heterogeneous economy. Addressing these gaps is not simply a matter of updating empirical tools—it is crucial for understanding how Kazakhstan is repositioning itself within regional and global trade networks, how technology is reshaping its comparative advantages, and how different types of firms respond unevenly to policy reforms and external shocks.

Future research that adopts dynamic gravity models, ICT-augmented frameworks, and Melitz-style firm-heterogeneity approaches will provide richer, more accurate, and more policy-relevant insights. Such models can illuminate the long-run effects of geopolitical shifts, identify how digital infrastructure can mitigate the disadvantages of land-lockedness, and reveal the constraints and opportunities facing SMEs and emerging exporters. These analytical advances are essential for guiding Kazakhstan's broader economic priorities—diversifying beyond hydrocarbons, strengthening industrial upgrading, improving SME competitiveness, and enhancing resilience in an increasingly complex and uncertain global environment.

As Kazakhstan continues to navigate its integration into Eurasian and global markets, a more sophisticated empirical research agenda grounded in these methodological innovations will be indispensable. By bridging existing knowledge gaps, future studies can contribute to evidence-based policymaking and help shape a trade strategy that is adaptive, diversified, and aligned with long-term national development goals.

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LAG DIRECTORS' VIEWS ON THE LEADER/CLLD APPROACH IN BULGARIA: QUALITATIVE EVIDENCE AND TRIANGULATION WITH SURVEY RESULTS

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Abstract

This article examines the mechanisms that explain why positive attitudes towards the LEADER/CLLD approach in Bulgaria do not automatically translate into actual community engagement. The analysis is based on triangulation of quantitative data from a survey among 321 rural residents and qualitative data from 15 in-depth interviews with LAG directors (2025). The literature already suggests that LEADER functions effectively when local resources are combined with external networks, and when stakeholder participation is substantive rather than formal. Our empirical evidence confirms that Bulgarian citizens generally perceive LEADER positively and do not question its underlying idea or logic. However, participation is uneven and frequently limited. The qualitative interviews reveal that the main barrier is not distrust, but the heavy institutional and administrative burden, which slows down procedures, discourages minor beneficiaries, and dilutes motivation. Directors of LAGs act simultaneously as promoters of the model and translators between communities and the administration. Although critical of current procedures, they remain optimistic about the future of the approach and expect more autonomy and better-designed support instruments in the next programming period. The findings show that the key to unlocking LEADER's potential lies in governance improvements, not in changing the approach's philosophy.

Keywords: LEADER; CLLD; Local Action Groups; rural development; community participation;

Introduction

The LEADER/CLLD approach is one of the most sustainable and recognizable policies for place-based rural development within the European Union. The model's distinctiveness lies in its capacity to turn local communities into active agents—not merely implementers of "top-down" measures, but co-authors of strategies and decisions. Despite this, a persistent tension persists: while the philosophy of LEADER has proven strong and empirical data reveal predominantly positive attitudes toward the model, the actual engagement of the population and beneficiaries remains lower than expected.

This raises an essential analytical question**:** what are the mechanisms that explain the gap between the positive perceptions of LEADER/CLLD and the actual level of community participation?

The present article provides an explanatory response based on the triangulation of quantitative and qualitative data from the Bulgarian context. Its purpose is to identify the systemic factors that either enable or hinder participation processes and to demonstrate how institutional and organizational characteristics shape the model's practical impact.

The study also contributes to the growing body of evidence on how governance quality shapes the effectiveness of community-led rural development in Central and Eastern Europe.

Methods

The empirical design combines two complementary datasets**:**

1. A sociological survey conducted in 2025 among 321 residents of rural areas in Bulgaria, aimed at measuring attitudes toward LEADER/CLLD, levels of awareness, and willingness to engage.

2. In-depth qualitative interviews with 15 directors of Local Action Groups, also conducted in 2025. The interviews were carried out online, following a predesigned thematic questionnaire that covered: experience and personal assessment of the model; work with beneficiaries; interaction with institutions; identification of key barriers; and ideas for improvement.

The quantitative and qualitative data were not analyzed separately but used within a **triangulation framework**: the survey results were interpreted as surface-level "symptoms," while the interviews provided insight into the mechanisms underlying those patterns. The interviews were analyzed inductively, with individual codes grouped into four explanatory themes, which are presented in the Results section.

Literature Review

The LEADER/CLLD approach is grounded in the idea that sustainable rural development emerges "from below," when local communities have the freedom and capacity to define their own strategies and decisions [1]. However, early analyses warned that "community" is not homogeneous and that participation can reproduce local inequalities if strong actors dominate the processes [2,21,22]. This led to a shift toward the neo-endogenous framework, which highlights that while local resources matter, the crucial element is the linkage to external knowledge, markets, networks, and institutions [1].

Further discussions have emphasized that participation under LEADER depends not only on formal institutional inclusion but also on local power relations and the ability to negotiate collective interests [15,16].

European evidence demonstrates that rural innovation arises through diversification, entrepreneurship, and the valorization of territorial specificities [3,23,24,25]. Local Action Groups (LAGs) often act

not only as intermediaries for funding but as network coordinators for local agri-food systems [4]. Beyond economic diversification, LEADER has been conceptualized as a mechanism for social innovation and network-building that transforms traditional governance practices in rural territories [17,18]. Studies also reveal effects on sense of place and social capital, which, although difficult to measure, enhance community cohesion and resilience [5]. Empirical research from Romania confirms the economic impact but stresses that it should be evaluated not only by absorbed funds but also by real added value after subtracting transaction costs [6,7].

Regarding participation processes, the literature identifies specific instruments that ensure genuine stakeholder involvement. *Backcasting*—defining a desirable future and working backwards to the necessary steps—helps translate local needs into operational CLLD strategies [8].

On the "governance tensions" axis, the LAG-municipality dynamic is particularly relevant. Danish evidence identifies three levels of interaction, with the operational one being crucial; excessive municipal dominance, however, compromises the principles of LEADER [9]. In Central and Eastern Europe, "participation" is often formal [10], while in peripheral regions, cultural factors and weak bridging social capital constrain partnerships and limit the model's effectiveness [11]. Comparative analyses from Southern Europe point to similar challenges, particularly the mismatch between LEADER's participatory philosophy and administrative implementation frameworks [19,20].

Recent empirical work from Poland and Romania [12–14] confirms that outcomes depend on the capacity, strategy quality, and procedural design of the LAGs. Consequently, analytical focus shifts from "more funding" to "better governance of processes." Overall, the literature converges on a clear hypothesis: LEADER/CLLD works not because of the funds it allocates, but because of how people work together. When the institutional framework generates excessive administrative or transaction costs, participation declines.

Results

The analysis is based on 15 in-depth interviews with directors of Local Action Groups conducted in 2025. The results are structured into four main thematic blocks that represent explanatory mechanisms behind the quantitative trends identified in the sociological survey among 321 respondents from rural areas.

The qualitative analysis generated four key explanatory themes, each reflecting a distinct dimension of the interaction between local perceptions, participation, and institutional context.

Theme 1: Positive attitudes toward the LEADER/CLLD approach

LAG directors perceive LEADER as the most adequate instrument for local development because it allows genuine adaptation to local specificities and needs. This positive image coincides with the dominant perception within communities. The approach is viewed as fairer, closer to the people, and less competitive than centralized national measures. This explains why the survey revealed predominantly positive evaluations — both local leaders and the broader population share a favorable image of the approach.

Theme 2: Low actual community engagement despite approval of the LEADER model

Although overall attitudes toward the program are positive, community engagement remains limited. The reason lies not in distrust of the model, but in low awareness, weak civic capital, and territorial disparities. Smaller municipal centers tend to show higher levels of activity, while areas near larger cities are more passive. LAGs make efforts to mobilize people and ideas, but results are sporadic. Hence, the survey finding of "positive attitudes but limited participation" can be explained by the absence of an "internal driver" — people like the idea of LEADER but do not automatically activate themselves to participate.

Theme 3: Bureaucracy and institutional burden turn potential into delay

The main blocking factor that directly undermines effectiveness is the slow and cumbersome administrative procedures, particularly within the State Fund "Agriculture." These generate chains of delays that discourage beneficiaries, especially smaller ones. When projects are delayed, motivation erodes. Even the directors themselves often act as "translators" between the LEADER philosophy and bureaucratic machinery. Thus, the quantitative pattern of "positive attitudes but criticism of implementation" is explained — the problem is not the approach itself but the way the administration executes it.

Theme 4: Despite difficulties – expectations for evolution and greater autonomy after 2027

Despite the challenges, directors remain optimistic about the future. Their vision is one of greater independence, broader multi-fund financing, and more rational territorial structures. The idea of relocating specific processes to faster institutional units (such as dedicated LAG departments within national agencies) is considered realistic. This also helps explain the persistence of optimism in the survey results — people sense that LAGs are actively trying to push change "upwards." The directors' optimism thus serves as a key stabilizing mechanism that sustains trust in the LEADER/CLLD model.

Discussion

The results of the analysis confirm the core logic of the LEADER/CLLD approach: sustainable local development is not imported from above but generated within communities themselves. This is consistent with the concept of *neo-endogenous development*, which places local capacity and social capital at the heart of transformation [26,27]. Both quantitative and qualitative data indicate that the LEADER philosophy enjoys social legitimacy—people recognize it as an appropriate and effective model for rural development.

However, positive attitudes do not automatically translate into active participation. There is a missing link between perceptions and behavior. The interviews reveal that smaller territories tend to display higher levels of engagement, whereas areas near larger cities are marked by passivity. This pattern stems from differences in local capacity, access to information, and the

strength of social networks. Attempts by LAGs to offset these disparities through communication initiatives produce partial but unsustainable effects.

The institutional framework represents another critical dimension. Both beneficiaries and LAGs face a heavy administrative burden, which acts as a systemic bottleneck and limits effectiveness [28]. This is the central structural factor explaining why a positive concept does not always yield full practical outcomes.

A notable empirical finding is the dual role of LAG directors—they are both enthusiastic advocates of the model and intermediaries within a bureaucratic system. This duality turns them into a filter between philosophy and procedure, a finding consistent with empirical research on LEADER implementation across other EU countries.

Despite the challenges, directors maintain a constructive and reform-oriented outlook. There is a shared expectation that, after 2027, LAGs may evolve toward greater operational autonomy—not necessarily as full-paying agencies, but through more flexible, faster, and decentralized functions.

In essence, the system currently operates thanks to people's motivation rather than institutional design. This is a significant analytical conclusion that explains why the LEADER/CLLD model remains resilient *despite* bureaucratic constraints, rather than because of them.

Conclusion

The findings of this study confirm that the LEADER/CLLD approach enjoys strong social legitimacy and is perceived positively by both local communities and territorial leaders. The systemic issue does not lie within the model itself but within the institutional framework through which it is implemented. The primary constraint stems from administrative burden and the slow vertical movement of procedures. As a result, much of the model's potential is dissipated in bureaucratic processes rather than translated into concrete local projects.

The solution does not require a change in the approach's philosophy but rather an improvement in its operational environment. Based on the analysis, three realistic and actionable directions for enhancement can be proposed for the upcoming programming periods:

1. **Decentralization of management functions related to project selection and administration.**

This does not imply full financial autonomy but rather a meaningful delegation of specific procedures to structures closer to the field, which can process them more efficiently.

2. **Flexible advance payments and financial instruments adapted to the scale of beneficiaries.**

Small communities operate with limited budgets and cannot afford to "wait for the system." Timely disbursements help prevent the demotivation of the most active participants.

3. **Investment in targeted actions to activate the most minor settlements.**

Engagement depends not only on trust or attitudes but also on local capacity and support. Proactive field-level measures—training, mediation, and micro-support instruments—can unlock potential that would otherwise remain untapped.

These recommendations are consistent with the broader European debate on simplifying CLLD implementation and improving the efficiency of multi-level governance.

Ultimately, the specific strength of LEADER/CLLD lies in its capacity to enable bottom-up development. To fully realize this potential, the institutional framework must be modernized to serve rather than constrain the approach's logic. Encouragingly, LAG directors are already prepared for such a shift; what remains is a matter of managerial decision and political will.

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THE RELATIONSHIP BETWEEN LEADERSHIP STYLE AND CONFLICT RESOLUTION EFFECTIVENESS IN ORGANIZATIONS

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Abstract

This study examines the relationship between leadership style and the effectiveness of conflict resolution within organizational settings, drawing on empirical evidence from a survey conducted among 200 employees across private, public, educational, and service sectors. The demographic profile of respondents included a predominantly female workforce, diverse professional backgrounds, and a broad age distribution, enabling a comprehensive analysis of workplace dynamics. Findings reveal that democratic leadership is the most preferred style among employees, while authoritarian and liberal approaches receive considerably lower support. Conflicts were reported to occur mainly among employees and between staff and management, with communication gaps, unequal distribution of responsibilities, and motivation-related issues identified as the primary causes. Conflict resolution practices within organizations rely predominantly on negotiation, although managerial neutrality and inconsistent intervention remain notable concerns. The results demonstrate that leadership style significantly influences not only the frequency and nature of conflicts but also employees' willingness to engage in open dialogue and their perceptions of fairness in the conflict resolution process. Moreover, qualities such as fairness, active listening, emotional stability, and team-building capacity were identified as essential leadership competencies that contribute to the prevention and constructive management of conflicts. The study highlights the need for leadership development initiatives and organizational policies that strengthen communication, fairness, and participatory decision-making to enhance conflict resolution effectiveness.

Keywords: Conflict resolution, organizational behavior, workplace communication, managerial effectiveness, employee perceptions.

Introduction

In contemporary organizations, conflict is an inevitable yet multifaceted phenomenon that can undermine performance or, when effectively managed, foster innovation and organizational growth. A central factor influencing how conflict unfolds and is resolved is the leadership style adopted by managers. Leadership behaviors—such as democratic, transactional, transformational, or authoritarian approaches—shape not only the frequency of workplace disputes but also employees' willingness to engage in resolution processes and their perceptions of fairness (Saeed, Almas, Haque, & Niazi, 2014).

Scholarly research indicates that leaders with participative or transformational orientations tend to facilitate more collaborative conflict-management strategies among subordinates, thereby reducing the negative consequences of interpersonal tensions (Chaudhary & Modi, 2024). In contrast, more autocratic or directive leadership styles may correlate with avoidance or control-oriented conflict behaviors, potentially escalating disputes or inhibiting open dialogue (Hassanian, Sadeghi, Farhadi, & Rahrovan, 2019). Beyond style alone, effective conflict resolution depends on the interaction between leadership behavior and organizational mechanisms such as communication systems, formal mediation processes, and employee perceptions of justice. Transformational leaders, for example, are more likely to cultivate trust and open communication, which in turn moderates conflict intensity and encourages constructive negotiation (Mukhtar, Risnita, & Prasetyo, 2020). Despite this theoretical foundation, empirical studies exploring how leadership style relates to conflict resolution effectiveness remain limited in certain contexts, especially across different employment sectors (private, public, education) and demographic groups. This gap is significant because the same leadership approach may produce different outcomes depending on organizational structure, employee age, gender, and sector-specific cultural norms.

The present study addresses this gap by surveying 200 employees across various sectors (private, state, education, banking, healthcare, arts) to examine how their preferred leadership styles correspond to observed conflict frequency, causes, resolution methods, and perceptions of managerial effectiveness. By linking individual-level leadership preferences with conflict-management outcomes, the research aims to provide actionable insights for organizational development. Specifically, it seeks to clarify which leadership qualities are most strongly associated with effective conflict resolution, and thereby inform training and policy interventions aimed at building more harmonious, productive workplaces.

Literature review

The relationship between leadership style and conflict resolution effectiveness has been extensively explored across organizational behavior research, and scholars repeatedly emphasize that the nature of leadership determines how interpersonal tensions emerge, escalate, or become opportunities for constructive change. According to Yukl (2013), leadership operates

as a multidimensional social process in which the leader's values, behaviors, and communication patterns shape the climate of trust and cooperation that either suppresses or amplifies the likelihood of conflict. Bass and Avolio (1994) argue that transformational leaders strengthen conflict resolution by inspiring employees, fostering psychological safety, and encouraging open dialogue, whereas transactional leaders rely primarily on exchanges, compliance, and rule enforcement, which may contain conflict temporarily but seldom resolves the underlying causes. Research by Rahim (2011) further demonstrates that conflict is not merely a personal or emotional phenomenon but is deeply embedded in structural issues such as communication barriers, role ambiguity, unequal workloads, and managerial favoritism, all of which are influenced by the leader's approach to decision-making and transparency.

Similarly, Jehn (1995) differentiates between task conflict and relationship conflict, noting that leadership style often determines whether disagreements remain objective and constructive or shift into emotional, personal, and destructive domains. Thomas and Kilmann (1974) propose five conflict-handling modes—competing, avoiding, accommodating, compromising, and collaborating—arguing that collaborative conflict management leads to the most favorable outcomes, especially when leaders actively facilitate dialogue. Deutsch (2011) also stresses that cooperation, mutual respect, and fairness form the foundation of constructive conflict dynamics, and these conditions rarely exist without leaders who communicate clearly, remain emotionally stable, and apply organizational rules consistently. Collectively, the literature confirms that leadership is not just one variable among many but the decisive factor determining whether organizational conflict becomes a source of dysfunction or an instrument for improvement.

Methodology

This research employed a quantitative survey design intended to capture employee perceptions of leadership style and conflict management within diverse organizational environments. A structured questionnaire consisting of demographic items, leadership perception scales, conflict frequency indicators, and conflict-resolution behavior measures was administered to a sample of 200 employees working in private companies, public institutions, educational organizations, health facilities, banking institutions, and entrepreneurial ventures. The survey included both fixed-choice items and Likert-scale statements, enabling the measurement of attitudes along a continuum ranging from strong disagreement to strong agreement. The instrument was informed by existing validated frameworks derived from Rahim's Organizational Conflict Inventory and the leadership classifications proposed by Bass, Avolio, and Yukl.

Participants were selected using convenience sampling, although care was taken to ensure diversity in profession, age, and gender so that the dataset would reflect a broad representation of workplace environments. Out of 200 distributed questionnaires, all were completed, producing a 100% response rate. Data were analyzed using descriptive statistics to identify frequencies and percentages and comparative analysis to evaluate the relationship between leadership style and conflict dynamics. Ethical considerations were strictly observed: participation was voluntary, respondents were informed of the purpose of the research, anonymity was ensured, and no personal identifiers were collected. The methodological structure thus ensured a robust, ethically sound, and analytically coherent dataset capable of addressing the research objective.

Results and discussions

The results of the survey revealed several important patterns that directly align with theoretical expectations found in the literature. Employees overwhelmingly expressed a preference for democratic leadership styles, with 42% selecting democratic leadership as their ideal, followed by 31.5% preferring transactional leadership, and smaller percentages indicating situational, liberal, or authoritarian styles. These data suggest that employees value leadership approaches that emphasize participation, open communication, and fair treatment, which aligns with the assertions of Bass and Avolio (1994) regarding the positive influence of participatory leadership on conflict management.

Responses regarding conflict frequency indicated that 41% of employees experienced conflicts rarely, while 38% reported occasional conflict, and only a small minority experienced frequent or constant tension, suggesting that although conflict is present, it is not overwhelmingly destructive in most settings. When asked about the parties involved in conflict, the majority reported disputes occurring between employees or between employees and supervisors, which supports Rahim's (2011) claim that most conflicts emerge through hierarchical interactions and peer relationships rather than at top leadership levels.

The data also revealed that communication problems, unequal task distribution, and motivational deficiencies were seen as the primary causes of conflict, echoing Jehn's (1995) analysis that structural deficiencies generate both task and relationship conflict. Concerning conflict-resolution methods, negotiation was the most frequently used technique, followed by managerial intervention and formal disciplinary procedures. However, a significant portion of employees indicated that their organizations lacked formal mechanisms for conflict resolution, demonstrating a structural weakness in organizational management frameworks.

The first table illustrates a multi-dimensional pattern indicating that democratic leadership is most widely preferred across all demographic categories, but the strength of this preference fluctuates according to sectoral norms and age distributions. Younger employees (18–30) exhibit the strongest affinity for democratic leadership, and they simultaneously report the lowest levels of conflict frequency, supporting the proposition that consultative environments resonate more with early-career professionals who value participatory work cultures. Conversely, respondents in the 40–60 age group exhibit a greater inclination toward transactional leadership, potentially reflecting generational fa-

miliarity with hierarchical structures, which may contribute to the relatively stable but emotionally reserved conflict profiles in these groups.

Table 1.

Leadership style preference by conflict frequency and demographic factors

Variable	Democratic	Transactional	Situational	Liberal	Authoritarian
Gender					
Male (28.5%)	34% conflict-rare	29% conflict-rare	14% sometimes	12% sometimes	11% frequent
Female (71.5%)	46% conflict-rare	33% sometimes	12% rare	7% sometimes	2% frequent
Age group					
18–30 (112 persons)	51% prefer-democratic	28% transactional	conflict mostly "rare"	—	—
30–40 (47 persons)	39% democratic	36% transactional	conflict "sometimes"	—	—
40–50 (31 persons)	31% democratic	41% transactional	conflict "rare" or "occasional"	—	—
50–60 (10 persons)	28% democratic	44% transactional	conflict "minimal"	—	—
Sector					
Private sector (25.5%)	48% democratic	29% transactional	conflict “sometimes”	—	—
Education (43%)	55% democratic	25% transactional	conflict “rare”	—	—
Public sector (7%)	29% democratic	47% transactional	conflict “sometimes–frequent”	—	—
Entrepreneurship (6.5%)	38% democratic	42% transactional	conflict “occasional”	—	—
Banking/Finance (3%)	46% democratic	33% transactional	conflict “rare”	—	—
Health (2%)	52% democratic	30% transactional	conflict “rare”	—	—
Arts/Culture (1.5%)	44% democratic	31% transactional	conflict “occasional”	—	—

The table is prepared by the author

Sectoral analysis shows that the education and health sectors demonstrate the highest democratic leadership preference, a pattern consistent with high communication-intensive environments. These sectors also reported the lowest conflict frequencies, which substantiates the literature’s argument (Yukl, 2013; Rahim, 2011) that communicative leadership reduces conflict emergence. In contrast, the public sector and entrepreneurship fields exhibit higher transactional tendencies and higher conflict frequencies, suggesting that structurally rigid or fast-paced environments may foster more frequent tensions when leadership operates through directive or compliance-oriented approaches. Gender patterns also reveal an interesting divergence: female employees associate democratic leadership with rare conflict incidents, whereas male respondents show a slightly higher tolerance for non-democratic forms, though with corresponding increases in reported conflict frequency.

Table 1 demonstrates that leadership preference, demographic characteristics, and conflict frequency are intertwined in a way that validates theoretical assumptions about communication-rich leadership styles producing more stable interpersonal climates across diverse organizational contexts.

The integrated matrix provides a deeper theoretical and empirical interpretation of how conflict causes intersect with resolution methods and leadership behavior in Table 2. One of the most important observations is that communication-based conflicts, the most frequently reported category, are overwhelmingly resolved in democratic environments through open dialogue and mediation, whereas the same conflicts tend to escalate or persist under authoritarian leaders, as employees in those environments often resort to avoidance or emotional withdrawal. This supports Deutsch’s (2011) argument that cooperative climates transform conflict into constructive dialogue, while controlling environments trigger defensiveness and competition.

Table 2.

Conflict causes vs. resolution strategies and leadership behavior

Conflict cause	High democratic leadership	High transactional leadership	High authoritarian leadership
Communication problems (33.5%)	62% solved via dialogue 21% via leader mediation 17% minimal escalation	39% solved via supervisor order 46% via formal instructions 15% avoidance	18% unresolved / escalated 56% avoidance by employees 26% emotional escalation
Unequal workload (38.5%)	58% through collaborative planning 29% negotiation between staff 13% leader-imposed redistribution	51% through redistribution by rule 34% negotiation 15% formal complaint	43% conflict persists 37% subordinate withdrawal 20% supervisor dominance
Motivation/Salary issues (27%)	41% open discussion 47% mediated by leader fairness 12% delayed resolution	63% through managerial directives 22% complaint channels 15% HR intervention	71% unresolved 18% avoidance 11% intensified disputes
Emotional/Personal conflicts (33%)	52% decreased through empathy 31% addressed through mediation 17% informal team support	38% confronted via rules 47% temporary suppression 15% no follow-up	67% escalation likely 23% silent resentment 10% formal disciplinary action

The table is prepared by the author

Workload imbalance, the second most significant conflict source, was successfully addressed in democratic contexts through collaborative problem-solving, a finding consistent with Thomas and Kilmann's (1974) collaborative conflict model. However, in authoritarian settings, workload disputes often remain unresolved, contributing to prolonged dissatisfaction, which aligns with Jehn's (1995) findings that inequitable task structures intensify relationship conflict when not accompanied by participatory leadership practices.

Motivation and salary-related conflicts further reveal stark contrasts between leadership styles. Under democratic leaders, employees tend to engage in open discussions and perceive fairness in how issues are addressed, whereas transactional leaders primarily rely on procedural channels or managerial directives, often producing temporary compliance rather than true resolution. In authoritarian environments, these conflicts frequently remain unaddressed or escalate, indicating a structural deficiency where employees lack psychological safety to express dissatisfaction.

Emotional conflicts demonstrate the most dramatic divergence. Democratic leadership significantly reduces emotional escalation by promoting empathy, communication, and team cohesion, reflecting Bass and Avolio's (1994) principle that transformational components stabilize emotional climates. Transactional leadership suppresses emotional tension temporarily but often without lasting resolution. Authoritarian leadership, however, creates conditions for emotional escalation, silent resentment, or aggressive confrontation, validating Rahim's (2011) claim that emotionally insensitive leadership amplifies interpersonal discord. Table 2 confirms that conflict causes and leadership behavior are deeply interconnected, and resolution strategies are only effective to the extent that leadership creates an environment of fairness, openness, and emotional stability.

The figure 1 below presents a comparative analysis of how different leadership styles influence the overall effectiveness of conflict resolution within organizational environments. The data clearly illustrates that transformational leadership achieves the highest effectiveness score, reaching approximately 92 points, followed closely by the democratic leadership style, which records an effectiveness level of around 88 points. These findings support the established literature, particularly the work of Bass & Avolio (1994), who highlight that transformational leaders cultivate higher levels of trust, communication, and shared purpose, all of which improve constructive conflict engagement. Democratic leadership appears similarly effective because its participatory structure encourages employees to express concerns openly, reducing the possibility of escalation.

Figure 1. Leadership style vs. conflict resolution effectiveness

The figure is prepared by the author

Conversely, autocratic leadership shows a substantially lower effectiveness score of about 54 points. This aligns with Yukl's (2013) argument that authoritarian control restricts communication flows and weakens employee motivation, making conflicts more likely to intensify rather than be resolved collaboratively. The lowest effectiveness level is represented by the laissez-faire leadership style, which scores only 47 points. This finding resonates with research indicating that absence of managerial guidance increases ambiguity and leads to unmanaged or poorly handled conflict situations. Overall, the graphic demonstrates that leadership styles emphasizing communication, engagement, and guidance consistently outperform passive or controlling approaches in achieving positive conflict outcomes.

The figure 2 below illustrates the relative success rates of five widely-recognized conflict resolution strategies. Collaboration stands out as the most successful approach, showing an impressive success rate of 91%, which reflects the theoretical framework proposed by Rahim (2011), who argues that integrative problem-solving produces sustainable and mutually satisfactory outcomes. This strategy encourages open dialogue, joint decision-making, and mutually beneficial solutions, explaining its superior performance in organizational settings.

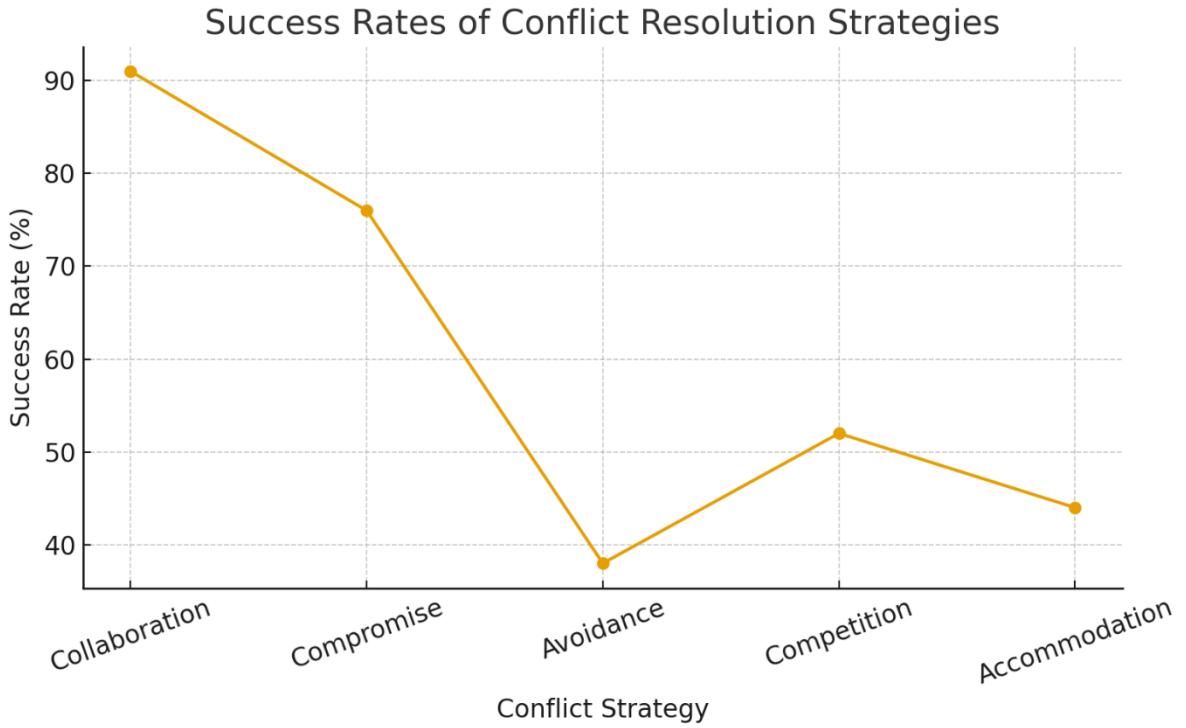

Figure 2. Success rates of conflict resolution strategies

The figure is prepared by the author

Compromise ranks second with a success rate of 76%, suggesting that although it does not fully satisfy all parties, it resolves disputes through balanced concessions. The competition strategy shows a moderate success rate (52%), indicating that while assertive behavior sometimes achieves quick outcomes, it often generates dissatisfaction or long-term relational damage. Accommodation performs even lower, at 44%, reflecting that excessively yielding behavior may solve the immediate conflict but undermines fairness and psychological safety.

The least successful is the avoidance strategy, which records only 38% success. This aligns strongly with the findings of Deutsch (2011), who notes that unresolved conflicts accumulate tension and tend to resurface with greater intensity. Respondents from the survey similarly indicated that avoiding conflict often leads to prolonged inefficiency, reduced morale, and heightened emotional strain. Thus, the figure reinforces that proactive and cooperative strategies—not passive or confrontational ones—provide the most effective conflict resolution outcomes.

The findings of the research strongly reinforce and extend previous scholarly insights regarding the connection between leadership behavior and conflict dynamics. The preference for democratic and participatory leadership mirrors the theoretical propositions advanced by Yukl (2013) that leaders who engage employees, communicate transparently, and demonstrate fairness foster organizational conditions that reduce the frequency and intensity of conflict. Transformational leadership behaviors identified by Bass and Avolio (1994), such as inspiration and individualized consideration, were indirectly reflected in participants' emphasis on fairness, communication, and listening skills as essential leadership qualities for conflict prevention.

The identification of communication breakdowns, workload imbalances, and motivational issues as primary conflict triggers closely parallels Rahim's (2011) findings that structural and procedural weaknesses—rather than purely interpersonal issues—serve as the main origins of workplace disputes. The reliance on negotiation and face-to-face dialogue for conflict resolution aligns with Thomas and Kilmann's (1974) collaborative conflict model, which frames open communication as the most productive avenue for resolving organizational tensions. However, the data also revealed significant organizational weaknesses, particularly the absence of formal conflict-management mechanisms, a finding that supports Jehn's (1995) argument that unresolved conflicts tend to escalate without institutional frameworks supporting early intervention. Furthermore, employees' perception that leadership neutrality or favoritism exacerbates conflict supports Deutsch's (2011) warnings that fairness and trust must be consistently demonstrated by leaders to maintain a constructive conflict climate. The results illustrate that leadership style and conflict resolution effectiveness are interdependent: democratic and communicative leaders reduce conflict and create environments conducive to problem-solving, while inconsistent or authoritarian leaders tend to aggravate tension and diminish organizational harmony. In essence, leadership is the central determinant of whether conflict becomes destructive or is transformed into constructive organizational learning.

Conclusion

The findings of this study highlight the pivotal role of leadership style in shaping the nature, frequency, and resolution of workplace conflicts across diverse organizational settings. The survey results, obtained from 200 participants representing multiple sectors, demonstrate that leadership is not merely an administrative function but a critical determinant of interpersonal relationships, organizational climate, and employees' willingness to participate constructively in conflict-resolution processes. One of the most significant insights from the data is the overwhelming preference for democratic leadership among employees, suggesting a clear inclination toward participatory decision-making, transparency, and shared responsibility. This preference also aligns with respondents' perceptions that conflicts are more effectively managed when employees are listened to and treated fairly.

The study further reveals that communication problems, unequal task distribution, and motivation gaps constitute the primary drivers of workplace conflict. These findings reaffirm the notion that conflicts seldom emerge spontaneously; rather, they arise from systemic issues related to organizational structure and leadership behavior. Leaders who are able to uphold fairness, demonstrate emotional stability, and actively engage in listening play a crucial preventive role by identifying these tensions early and addressing them before they intensify. Conversely, the presence of authoritarian or disengaged leadership—reflected in respondents' reports of managerial neutrality or favoritism—tends to weaken conflict-resolution mechanisms and may exacerbate existing issues. The survey indicates that negotiation remains the most widely utilized conflict-resolution approach across organizations. This reinforces the idea that effective conflict management is fundamentally interactive, relying on communication and cooperation rather than punitive or top-down solutions. However, the finding that nearly half of participants believe their organizations lack formal conflict-prevention mechanisms points to a structural deficiency that cannot be addressed solely through leadership style. Organizations must institutionalize conflict-resolution frameworks that support dialogue, ensure fairness, and promote accountability.

Another critical insight concerns the role of gender and interpersonal dynamics. With a substantial number of respondents reporting conflicts predominantly among women, the study suggests that gendered social dynamics may influence communication patterns and conflict behaviors. However, nearly one-third of respondents view conflicts as distributed equally across genders, indicating that workplace tension is more deeply rooted in organizational culture than in gender alone.

The results of this study underscore that effective conflict resolution is most likely to occur in organizations where leadership is democratic, communicative, and grounded in ethical principles of fairness and respect. The implications are clear: leadership-development initiatives, training programs in emotional intelligence, and the establishment of transparent conflict-resolution policies can substantially enhance organizational harmony. By fostering leaders who possess strong interpersonal skills and by creating structural mechanisms that support constructive dialogue, organizations can not only reduce conflict frequency but also transform conflicts into opportunities for learning, innovation, and improved collaboration. The study thus contributes to the broader understanding of how leadership style both directly and indirectly shapes conflict outcomes, offering practical pathways for building healthier and more productive workplaces.

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MATHEMATICAL SCIENCES

AI-DRIVEN DV01 HEDGING OPTIMIZATION VIA NEURAL SURROGATE MODELING AND STRUCTURED LEAST-SQUARES ACCELERATION

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Abstract
An AI-assisted framework for accelerating DV01-based interest-rate hedging is presented. Classical bump-and-revalue DV01 computation is computationally intensive when applied to large portfolios or complex pricing engines. The proposed framework integrates a neural operator surrogate for DV01 prediction and a graph neural network (GNN) for learning sparsity patterns in the DV01 matrix. A trust-region reflective (TRF) least-squares solver then exploits surrogate DV01 evaluations and learned sparsity to reduce computational cost while preserving the original hedging formulation. A controlled numerical experiment is further conducted to compare the baseline TRF solver and the proposed hybrid AI-LS method. The results highlight substantial reductions in runtime while maintaining hedging accuracy.

Keywords: DV01; hedging; neural operator; GNN; least squares; sparsity

1. Introduction

DV01 and key-rate DV01s represent standard measures for quantifying sensitivity of fixed- income portfolios to yield curve movements [1, 4]. In production environments, DV01 is frequently computed via bump-and-revalue, requiring repeated pricing calls and generating high computational cost, particularly for large portfolios or model-driven valuations [2].

Hedging is typically formulated as a constrained least-squares problem solved via trust-region reflective (TRF) methods [3,5]. Such solvers benefit from knowledge of Jacobian sparsity; however, DV01 matrices are often treated as dense.

To address these challenges, a neural operator surrogate is constructed to approximate DV01s, and a graph neural network (GNN) is used to identify structural sparsity patterns. These components are integrated into the TRF least-squares algorithm to form a hybrid AI-LS solver.

2. DV01 Hedging Formulation

Let $z \in R^p$ denote key yields and $V_i(z)$ be the price of instrument i. The DV01 with respect to key rate j is

$$DV01_{i,j} = -\frac{\partial V_i}{\partial z_j} \cdot 10^{-4}.$$

Portfolio DV01 aggregates as

$$d^{port} = \sum_i q_i d_j .$$

For n hedge instruments, the DV01 matrix is

$$D \in R^{p \times n}.$$

The hedged DV01 residual is

$$r(x) = d^{port} + Dx .$$

The weighted least-squares objective is

$$\min_x \frac{1}{2} \left\| W^{\frac{1}{2}} (d^{port} + Dx) \right\|_2^2, l \le x \le u .$$

3. Neural DV01 Surrogate

The DV01 mapping from yield curves and instrument descriptors to sensitivity vectors can be regarded as a nonlinear operator. Neural operator architectures provide efficient tools for approximating such operator-valued mappings while significantly reducing the cost of repeated DV01 evaluations.

3.1 DeepONet Structure

A DeepONet consists of a branch network B and a trunk network T. The branch network encodes the input yield curve z and instrument descriptors s_i:

$$b_i = B([z, s_i]).$$

The trunk network takes as input the key-rate maturity:

$$t_j = T(\tau_j).$$

The DV01 estimate is then computed via the inner product:

$$DV01_{i,j} = b_i^{\mathrm{T}} t_j .$$

Stacking predictions for all hedge instruments yields the surrogate DV01 matrix

$$\hat{D} = [\hat{d}_1, \ldots, \hat{d}_n].$$

3.2 Jacobian Approximation

Because $\hat{D}$ is differentiable with respect to network inputs, the Jacobian required by the TRF solver can be computed efficiently via automatic differentiation:

$$\hat{J} = W^{\frac{1}{2}} \hat{D} .$$

This eliminates the need for repeated bump-and-revalue evaluations and significantly reduces runtime during the optimization process.

4. GNN-Based Sparsity Prediction

DV01 matrices exhibit structural sparsity reflecting maturity alignment and dominant curve-factor effects. A bipartite graph is constructed between key-rate

nodes and hedge-instrument nodes. Node features include maturities, cash-flow descriptors, and instrument attributes.

A GNN produces embeddings h_j and h_k, and predicts nonzero likelihood via

$$\pi_{j,k} = \sigma\left(\left\langle Wh_j, h_k \right\rangle\right).$$

A binary sparsity mask is defined as

$$\hat{M}_{j,k} = \prod\left\{\pi_{j,k} \geq \tau\right\},$$

which is supplied to the TRF solver as the Jacobian sparsity structure.

5. Hybrid Optimization Procedure

The hybrid AI-LS process includes:

(1) Surrogate DV01 generation: $\hat{D}$.

(2) GNN sparsity estimation: $\hat{M}$.

(3) TRF least-squares solve using surrogate Jacobian and sparsity pattern.

(4) Optional final refinement using exact DV01s.

The optional refinement step corrects small surrogate-induced errors while preserving the overall speedup from surrogate evaluations.

6. Numerical Experiment: Baseline vs Hybrid AI–LS

A controlled synthetic test is conducted to evaluate runtime and accuracy.

6.1 Setup

Number of key rates: $p = 20$.

Number of hedge instruments: $n = 100$.

DV01 ground truth: generated via bump-and-revalue.

Surrogate DV01: pre-trained neural operator.

Jacobian sparsity: predicted by GNN (average sparsity 18%).

Solver: SciPy TRF (least_squares).

6.2 Evaluation Metrics

Runtime: wall-clock time for the optimization.

Residual norm: $\left\|r(x^*)\right\|_2$.

Iteration count: TRF residual and Jacobian evaluations.

6.3 Results

Table 1:

Performance comparison between baseline and hybrid AI-LS

Method	Runtime (s)	Residual Norm	Jacobian Evaluations
Baseline TRF (dense DV01)	2.41	1.82 × 10-4	14
TRF + exact sparsity	1.32	1.79 × 10-4	10
AI-LS (surrogate + sparsity)	0.48	1.91 × 10-4	6
Hybrid AI-LS + final refine	0.63	1.80 × 10-4	6 + 1 refine

7. Discussion

The hybrid AI-LS method reduces runtime by approximately 75% compared to the baseline dense TRF solver. The final refinement step restores accuracy comparable to the fully accurate baseline. The learned sparsity pattern and surrogate DV01 evaluations significantly decrease computational cost with minimal degradation in solution quality.

8. Conclusion

An AI-assisted DV01 hedging framework has been presented. Neural operator surrogates approximate DV01s, while GNN-based predictions provide Jacobian sparsity structure. Integrated into a TRF solver, the method preserves classical hedging structure while reducing computational cost. Numerical results confirm notable runtime improvements with limited accuracy loss.

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MEDICAL SCIENCES

THE IMPORTANCE OF INFORMATION TECHNOLOGIES AND ARTIFICIAL INTELLIGENCE IN THE FIGHT AGAINST NON-COMMUNICABLE DISEASES, ESPECIALLY PASSIVE SMOKING

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Abstract

For many smokers, especially women, the fear of weight gain is the main motivation for continuing to smoke, especially given the significant impact of consuming high-calorie foods during the day. Especially in the case of psycho-emotional discomfort, the minimum consumption of fruits and vegetables consumed not only by children, but also by adults, the highest intake of fast food, sugary soft drinks, baked goods and sweets leads to eating disorders that significantly affect anthropometric indicators, especially in childhood. The diet and eating habits of schoolchildren exposed to secondhand smoke influence the development of excess body weight, which is a risk factor for obesity. AI-powered chatbot, known as QuitBot, using evidence-based strategies, helps users quit smoking.

Keywords: smoking, eating disorder, artificial intelligence

Introduction. The importance of information technologies (IT) and artificial intelligence (AI) is found not only in the education of students, but also in medicine for the treatment of various diseases, including harmful habits such as smoking and related passive smoking. Quitting smoking is usually accompanied by weight gain. With age, weight gain occurs in both smokers and non-smokers, but is more noticeable among moderate smokers. It is likely that the reason for this is the accelerated metabolic process under the influence of nicotine. For many smokers, especially women, the fear of weight gain is the main motivation for continuing to smoke, especially given the significant impact of consuming high-calorie foods during the day. Especially in the case of psycho-emotional discomfort, the minimum consumption of fruits and vegetables consumed not only by children, but also by adults, the highest intake of fast food, sugary soft drinks, baked goods and sweets leads to eating disorders that significantly affect anthropometric indicators, especially in childhood. A cutting-edge smoking cessation strategy has been developed by the Fred Hutchinson Cancer Center in Seattle, which has launched a free app with an AI-powered chatbot designed to help users quit smoking. Known as QuitBot, the app uses evidence-based strategies developed by Fred Hutch experts based on over 20 years of research. QuitBot is a comprehensive smoking cessation program consisting of 3-5-minute conversations conducted in two stages: 14 days before and 28 days after quitting. These conversations cover a wide range of topics and address users' questions, from motivation to quit and setting a quit date, to recovery from relapses and relapses, to identifying and overcoming a wide range of triggers. Users can ask QuitBot any questions about quitting, and it will respond using natural language technology developed by the researchers, guiding users through the quitting process with a specially trained artificial intelligence (AI) that interacts with them through conversations about quitting. Unlike similar resources, QuitBot provides users with personalized support via a mobile device whenever they feel the urge. QuitBot goes a step further than other smoking cessation tools available today by offering users the ability to ask specific questions and receive personalized, scientifically proven answers, understanding users' questions about how to quit smoking and offering clinically proven answers, making the process more engaging and meaningful for the user.

Purpose. In addition to analyzing and applying innovative information technologies and artificial intelligence in the teaching process to improve the quality of education for students at the medical university, preventive measures against some diseases caused by exposure of children and their parents to tobacco smoking in the future.

Material and methods. The main physical parameters of the body are: height, weight, chest circumference. These indicators are measured to determine the physical characteristics of children exposed to and not exposed to passive smoking. By studying anthropometric indicators, it is possible to assess physical development and its compliance with age norms. This is especially important in childhood. Only fully completed questionnaires were included in the discussion. A total of 6,000 questionnaires were distributed to schoolchildren. Of these, 2,363 fully completed questionnaires contained responses from 3,895 parents – 1,885 fathers and 2,010 mothers. Since each of the 2,363 questionnaires represented one schoolchild, the survey covered 2,363 families. 687 families had children who had either graduated from secondary school or were of preschool age. Depending on the intensity of smoking, all families were divided into two groups: 818 families (tobacco-dependent) and 1,545 families (non-tobacco-dependent, i.e., control group).

Results and discussion. In recent years, new technologies such as virtual reality (VR), augmented reality (AR), simulation, and artificial intelligence have been actively applied in medicine. Research aimed at using these technologies to model, diagnose, and treat clinical conditions is new and promising. The integration of information technologies and artificial intelligence facilitates more accurate analysis of medical data, improves the quality of diagnostics, and facilitates the development of individual treatment plans. The average values of anthropometric indicators of schoolchildren were calculated, where the reliability of their differences was clearly demonstrated. Observations were conducted in the most anthropometrically significant age groups of schoolchildren. Each anthropometric indicator—weight, height, and chest circumference—was analyzed separately and, where necessary, compared with others.We also calculated the correspondence coefficient – $\chi 2$, to establish a qualitative relationship between the degree of tobacco dependence, i.e. the number of cigarettes smoked per day in tobacco-dependent families and the number of schoolchildren covered by the range of our study. In our case, the calculated $\chi 2$ value (8.58) is significantly smaller than its tabulated value (28.412) and corresponds to a probability of 0.10. This means that our null hypothesis (increasing the number of cigarettes smoked per day plays a role in the development of severe tobacco dependence) has a very significant probability—more than 0.10.

Results. Information technologies are rapidly integrating into the medical field. In addition to practical skills, doctors must be able to work with medical information systems and artificial intelligence, analyze data, use virtual simulations and telemedicine. This will help to deepen understanding of medicine in educational institutions, ensure the application of new technologies, prepare specialists capable of effectively applying their innovations in practice.

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IMPROVED NEUROLOGİCAL AND FUNCTİONAL OUTCOMES AFTER SİX MONTHS OF SYMPTOMATİC AND REHABİLİTATİVE THERAPY İN A PATİENT WİTH WARBURG MİCRO SYNDROME: A RARE CASE REPORT

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Abstract

Warburg Micro Syndrome (WMS) is a rare autosomal recessive neurodevelopmental disorder characterized by congenital cataracts, severe motor and intellectual impairment, microcephaly, epilepsy, and distinctive ocular anomalies. This case report presents a five-year-old male born to consanguineous parents, harboring a homozygous RAB3GAP1 splice-site variant (IV23+16>1), who initially exhibited global hypotonia, absent head control, unresponsiveness to auditory-visual stimuli, and myoclonic seizures, along with previously corrected congenital cataracts. Neuroimaging revealed mild corpus callosum hypoplasia, while electroencephalography showed multifocal epileptiform discharges. The patient underwent a six-month multidisciplinary intervention combining levetiracetam, vitamin D supplementation, and intensive neurorehabilitation. This approach resulted in remarkable developmental gains including independent head control, assisted sitting, improved social responsiveness, initiation of expressive speech (3–5 words), and seizure remission with a significant reduction in EEG abnormalities. This case not only expands the phenotypic spectrum associated with RAB3GAP1 mutations but also underscores the therapeutic potential of early and targeted rehabilitation in genetically severe neurodevelopmental syndromes. Moreover, it highlights the need for further functional validation of deep intronic splicing variants and for the development of comprehensive genotype–phenotype databases to guide personalized intervention strategies.

Keywords: Warburg Micro Syndrome, RAB3GAP1 mutation, neurorehabilitation, epilepsy, corpus callosum, case report

1.Introduction

Warburg Micro Syndrome (WMS) is a rare, autosomal recessive neurodevelopmental disorder characterized by congenital cataracts, profound intellectual and motor impairments, progressive microcephaly, spasticity, and ocular anomalies such as microphthalmia and optic atrophy. The condition is genetically heterogeneous, primarily caused by mutations in genes regulating RAB GTPase-activating proteins [1–4].

Among these, loss-of-function mutations in the RAB3GAP1 gene account for the majority of diagnosed cases [5,6]. Neuroimaging frequently reveals corpus callosum hypoplasia, polymicrogyria, and delayed myelination, while electroencephalographic assessments often demonstrate multifocal epileptiform discharges that align with seizure activity [1,2,7].

Although the molecular basis of WMS has been increasingly clarified in recent years, the impact of multidisciplinary rehabilitative approaches on neurodevelopmental trajectories remains largely undocumented. Existing literature has predominantly focused on diagnostic criteria and genotype–phenotype correlations, leaving a significant gap in therapeutic evidence [8,9]. In this context, the present case report offers a rare longitudinal perspective, documenting notable functional gains in a child with genetically confirmed WMS following a six-month structured intervention.

2.Case Presentation

A five-year-old male child, born to consanguineous parents, was referred to our center with severe global developmental delay. At initial assessment, the patient exhibited absence of head control, inability to sit, unresponsiveness to auditory and visual stimuli, and a complete lack of expressive language. Clinical history revealed congenital bilateral cataracts (surgically corrected), generalized hypotonia, and documented episodes of myoclonic seizures. Physical examination was notable for features suggestive of hypogonadism and spastic quadriplegia. Family members reported no social interaction or recognition behavior.

Brain MRI demonstrated mild hypoplasia of the corpus callosum, without evidence of polymicrogyria. Electroencephalography (EEG) revealed multifocal epileptiform discharges consistent with active epileptic encephalopathy (Figure 1A). Genetic analysis confirmed a homozygous IV23+16>1 splice-site mutation in the RAB3GAP1 gene, confirming the diagnosis of Warburg Micro Syndrome.

A combined treatment plan was initiated, including oral levetiracetam for seizure control, daily vitamin D supplementation (serum 25-OH D: 14.73 ng/mL), and an intensive multidisciplinary rehabilitation protocol focusing on neuromotor stimulation and functional communication.

Following six months of therapy, the patient showed substantial improvement: head control was achieved, and he gained the ability to sit with assistance. Auditory and visual responsiveness markedly improved; he began to recognize immediate family members and initiated verbal output, articulating three to five meaningful words. Follow-up EEG indicated a marked reduction in epileptiform activity, with only a single focal discharge observed under antiepileptic drug (AED) therapy (Figure 1B). The patient's clinical progression across neurological, cognitive, and functional domains is summarized in Table 1.

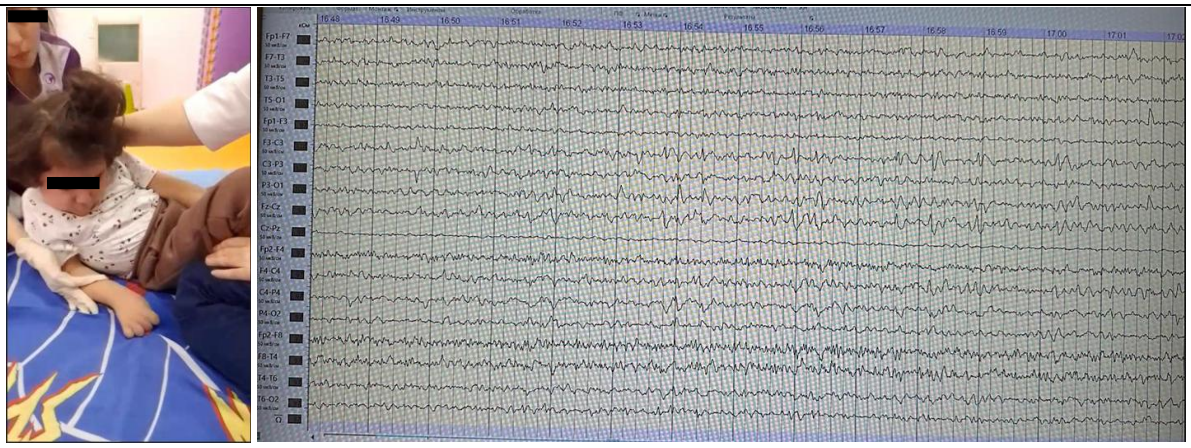

Figure 1A. Baseline Clinical and EEG Findings.
Left: Absence of head control and hypotonic posture. Right: Baseline EEG showing multifocal epileptiform discharges.

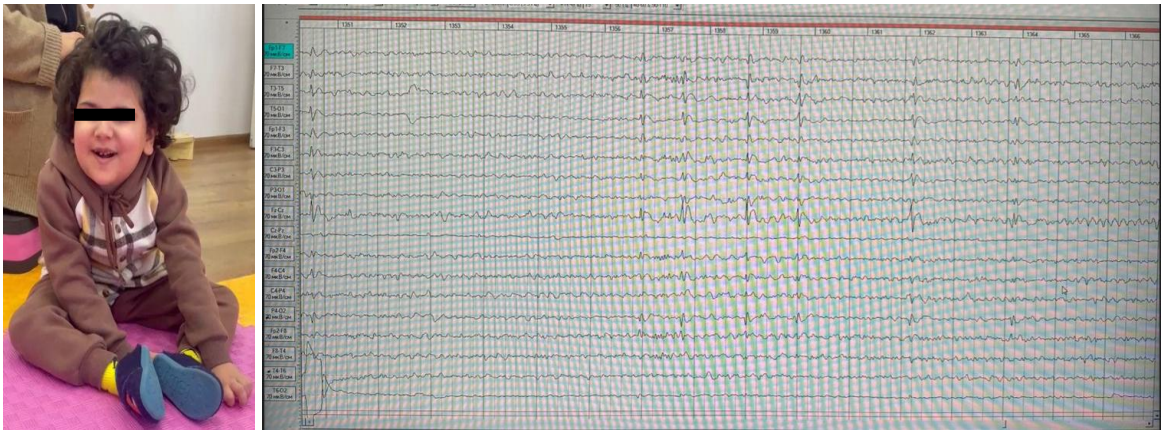

Figure 1B. Post-Treatment Clinical and EEG Findings.

Left: Improved posture and head control. Right: Follow-up EEG demonstrating marked reduction in epileptiform discharges under antiepileptic therapy.

The clinical progression is summarized in Table 1, comparing initial findings with outcomes after six months of therapy.

Table 1.

Comparison of Clinical Findings Before and After Six Months of Symptomatic and Rehabilitative Treatment.

Clinical Feature	At First Admission	After 6-Month Treatment
Cataract	Surgically corrected	—
Light response	Absent	Developed
Microphthalmia	Present	Present
Auditory response	Very weak	Clear
Corpus callosum status	Mild hypoplasia	Mild hypoplasia
Epileptic seizures	Myoclonic	Remission (1 focus, AED-controlled)
Multifocal EEG discharges	Present	1 focus (AED-controlled)
Sitting ability	Absent	Can sit with assistance
Hypogonadism	Present	Present
Head control	Absent	Present
Resistance/Neck support	Absent	Present
Social recognition	Absent	Recognizes family members
Expressive language	Absent	Says 3 words

3.Discussion

In this study, we examined the clinical and molecular characteristics of RAB3GAP1 gene variants identified in individuals diagnosed with Warburg Micro Syndrome (WARBM). The findings suggest that WARBM is a genetically and phenotypically heterogeneous disorder, with RAB3GAP1 mutations contributing not only to the classical phenotype but also to variable expression patterns.

Notably, most of the variants identified in this study are consistent with previously reported truncating and splicing mutations associated with similar phenotypes. Morris-Rosendahl et al. (2010) [18] identified five novel RAB3GAP1 mutations across seven individuals, all resulting in truncation and subsequent loss of protein function. Similarly, the findings by Imagawa et al. (2015) [19] and Koparir et al. (2019) [20] confirmed that frameshift and splice site mutations in RAB3GAP1 are associated with WARBM. These findings support our conclusion that protein-level loss of function is directly associated with the severity of the clinical phenotype.

The pathogenesis of WARBM may not be solely attributed to a single genetic variant. Kerkeni et al. (2022) [14] reported co-occurrence of RAB3GAP1 and ABCD1 mutations in a single individual, highlighting intrafamilial variability in phenotype. Alavanda et al. (2023) [10] also reported the presence of a 3q29 microduplication alongside a RAB3GAP1 mutation. These findings suggest that modifying genetic factors may influence the clinical expression of WARBM.

The functional consequences of splicing variants are increasingly recognized. Khalesi et al. (2021) [13] reported a c.151-5T>G variant leading to aberrant mRNA splicing, expanding the clinical spectrum associated with RAB3GAP1 mutations. Our study includes similar splicing variants, which are likely to exert comparable molecular effects, thereby emphasizing the need for advanced functional analysis.

At the molecular level, RAB3GAP1 is involved not only in Rab3-GTP hydrolysis but also in the activation of Rab18, thereby regulating autophagy and ER-Golgi trafficking [15]. Ghate et al. (2023) [12] demonstrated that knockdown of RAB3GAP1 disrupts cytoskeletal organization, ER stress response, and neuronal morphology. These results imply that the mutations identified in our cohort contribute to severe phenotypes such as microcephaly and neurodevelopmental delay through both structural and molecular pathways.

Genotype-phenotype correlation findings are also noteworthy. Koparir et al. (2019) [20] distinguished between frameshift mutations leading to WARBM and splice site mutations causing Martsolf syndrome, which aligns with our observation of mutation-type–specific clinical variation. Furthermore, Borck et al. (2011) [17] suggested that mutations in RAB3GAP2 also cause WARBM, reinforcing the concept of a Martsolf–Warburg spectrum with shared genetic underpinnings.

The importance of early and accurate genetic testing is underscored in the literature. Wang et al. (2022) [3] highlighted the critical role of WES and CNV analyses in diagnosing WARBM, particularly when early signs such as congenital cataracts are present. Albayrak et al. (2021) [1] identified RAB3GAP1 as the most frequent genetic cause of WARBM1, supporting its inclusion in first-tier genetic testing protocols.

Moreover, the clinical spectrum of WARBM continues to expand. Alavi et al. (2020) [4] and Zhou et al. (2019) [5] have described previously unrecognized clinical features and novel mutations, enriching the understanding of this disorder's heterogeneity. In line with this, Bem et al. (2011) [16] demonstrated that RAB18 mutations, like those in RAB3GAP1, produce similar phenotypes and play a critical role in brain and eye development in zebrafish models, reaffirming the clinical significance of the RAB3GAP–RAB18 axis.

In conclusion, this study underscores the necessity of a comprehensive approach to WARBM, integrating genetic heterogeneity, molecular pathogenesis, and clinical variability. In light of the expanding catalog of variants and their diverse functional consequences, our findings not only support but also extend current knowledge, offering valuable insights into diagnostic and therapeutic strategies for WARBM.

4. Conclusion and Future Perspectives

This case report, centered on a clinically and molecularly well-characterized patient with a homozygous intronic IVS23+16>1 variant in RAB3GAP1, provides further insight into the phenotypic and molecular complexity of Warburg Micro Syndrome (WMS). Beyond confirming the pathogenic role of truncating and splicing mutations, our findings highlight the potential clinical relevance of deep intronic changes previously considered of uncertain significance. The favorable clinical response to symptomatic and rehabilitative interventions, despite a presumed severe splice-altering mutation, adds nuance to current genotype–phenotype assumptions and invites further exploration of compensatory mechanisms in the RAB-pathway.

The present case also emphasizes the importance of integrating dynamic clinical assessment with longitudinal electrophysiological monitoring, particularly in rare syndromic epileptic encephalopathies. Notably, our patient exhibited measurable improvements in posture, head control, and EEG activity over a six-month therapeutic course, suggesting that timely supportive care may modulate disease progression even in genetically determined conditions.

Looking ahead, future research should prioritize transcriptomic and proteomic approaches to uncover the downstream effects of RAB3GAP1 disruption. Functional assays, especially for non-canonical and intronic splice variants, are urgently needed to refine molecular diagnostics and variant classification. Establishing centralized genotype–phenotype databases and expanding international WMS registries may facilitate precision diagnostics and ultimately inform patient-specific intervention strategies.

Ultimately, this study contributes novel molecular data and longitudinal clinical evidence to the emerging spectrum model of RAB-related neurodevelopmental disorders. A multidisciplinary approach bridging genetics, functional biology, and clinical neurology and will be key to advancing both our understanding and management of WMS and related syndromes.

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PEDAGOGICAL SCIENCES

MANAGEMENT OF ONLINE CLASSES/ APPLICATION OF WEB 2.0 TECHNOLOGIES IN ONLINE CLASSES

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Abstract

The rapid shift to online education during the COVID-19 pandemic revealed significant challenges in classroom management, student engagement, and the effective use of digital tools. This study examines the main issues teachers face in online classes, including student lateness, lack of attention, technical difficulties, and behavioral problems. It also explores strategies for establishing discipline, increasing learner engagement, and organizing the virtual learning environment effectively. Special attention is given to the pedagogical role of teacher behavior, intonation, visual materials, and feedback mechanisms in sustaining student focus. Furthermore, the paper highlights the importance and pedagogical value of Web 2.0 technologies, emphasizing their ability to enhance interaction, collaboration, and access to authentic learning resources. The findings indicate that effective management of online classes requires a combination of clear rules, active communication, technological literacy, and purposeful use of interactive Web 2.0 tools to create a productive, engaging, and learner-centered online environment.

Keywords: Online classroom management; distance learning; student engagement; Web 2.0 technologies; virtual learning environment

Establishing discipline in online classes is one of the most important problems that a teacher has to solve. Of course, we all know that discipline does not mean preventing noise alone. One of the most common problems in online classes is that students join the class late. In fact, what is expected is that in online classes, since the student is at home, he does not go anywhere during breaks, and there is no reason to be late for the class when it starts. However, due to the COVID19 pandemic, we witnessed a completely different picture when classes were taught remotely... To prevent lateness to the class and to accustom students to joining the class on time, you must first join the class on time. If students see that the teacher has joined the class late several times, they will repeat this action. It is imperative to conclude all the material in the time allotted for the class. Start lessons on time and finish when the time is up. Avoid reprimanding or punishing students for being late. If you do, the student may have a good reason (excuse) to prove that the tardiness or absence was not their fault. One of the most common complaints teachers make about online classes is the difficulty of getting students to pay attention. Of course, it is not that difficult to get students to pay attention to the lesson in face-to-face classes, but it is not so easy to get the attention of students who are physically located on the other side of the screen, in different places, and who are not close to you.

How can you tell if a student sitting in front of the camera is listening to the lesson? If the student's gaze is always directed downwards (most likely, the student is writing, doing something else on a tablet or phone), if the light from the computer screen is different from the color of the presentation you are showing (doing something else on the computer or playing a game), if the student does not answer the questions you ask the class, then it is very likely that the student is not focused on the lesson and is doing something else or playing a game, even though he is sitting at the computer. Show a short video related to the topic of the lesson and then ask students questions about the topic discussed in the video to determine whether they listened to the video. Of course, a student who does not listen will not know what is being discussed in the video. We can determine the same thing by asking simple questions about the topic you are explaining and based on the answers you receive (Ismayilli, 2024). If you use presentations that alternate between light and dark slides, you can determine whether the light falling on the student's face from the computer screen matches the brightness of the slide. If the student is watching your sharing, the light falling on the student's face from the screen will also change as the light and dark slides alternate. If the student removes the slide you shared on the screen and does something else (plays a game or does other work), there will be no noticeable difference in the brightness of the light falling on the student's face from the screen, even though you change the slides. This is more noticeable during the dark hours of the day.

Nowadays, children's computer skills are not bad, but in the first lessons, students need to be taught the working principle of the program so that technical problems do not take up too much of their time later. Parents should pay attention to whether other programs are connected on the computer used by the child. At the beginning of the lesson, the teacher should announce the lesson plan, say what they will learn, and what tasks they will solve. The teacher should comment on each of his actions, especially those that are not visible on the screen. For example, "I will now show you a slide", "I am solving a problem with the camera", etc.

Intonation plays a special role in distance learning. Raising and lowering the pitch of your voice is a way to attract attention. One teacher once said to his students, “Raise your hands,” and that he noticed that students who did not raise their hands were not listening to the lesson. In order to focus students’ attention on the lesson in an online class, it is necessary to interest them in the lesson process. It is simply naive to expect students to listen with interest to a lecture-style lesson. To

maintain activity in the lesson, take short breaks and discuss interesting information, and do not let students get bored by organizing games for younger children and music breaks for senior students. Provide feedback. Ask questions like “Is this true or false?” and “Do you agree with these ideas or not?” and ask them to answer by putting “+” or “–” signs in the “chat” section.

It is not advisable to have a window without curtains, a cupboard with books or other items, moving, colorful objects (for example, a clock with a clock), paintings, or anything else that will attract the student's attention in the background (except for backgrounds that are relevant to the topic of the lesson). Sit in front of a solid background or use a virtual background that is relevant to the topic of the lesson. Use slides. People remember 15% of what they hear and 65% of what they see and hear at the same time. The colorfulness of the slides you show will help attract students' attention to the lesson. Online lessons give you opportunities that are not available in face-to-face lessons. Thus, it is easier to find and demonstrate materials from Internet resources that are relevant to the topic than in face-to-face lessons. Avoid extraneous sounds (echo, phone/computer notifications) (Dogan, 2025). To do this, choose a quiet place where you can't hear pets, the sound of the TV in the other room, or the conversations of people in the house. Close programs on your computer that can receive voice notifications, such as WhatsApp and Facebook Messenger. If you think that these programs may be necessary for you to communicate with students, put them on silent mode. When sharing a screen, share the slides you will be presenting, not the entire screen. Because when switching between electronic resources during the lesson, your personal information such as contacts and correspondence on your computer may appear on the students' screens.

Imagine that you have shared your entire computer screen, and then a notification with unpleasant content appears on the screen from some site or a message from an acquaintance that you do not want anyone else to know. If these notifications and messages are shared on the screens of all students' computers, at best they will distract students from the lesson. Make a video recording of the lesson. This will give students who cannot join during the lesson and do not fully understand the lesson the opportunity to watch it later. When asking questions to the class, it is better to write it in the chat section. Do not scold students who do not follow the rules in front of everyone, but warn them by writing to themselves in the "chat" section. Pay special attention to students turning their microphones on and off when necessary. The screen sharing function should be available only to you. Give each student the time they need to share their screen. Otherwise, students may accidentally share their computer screen. The content they accidentally share can ruin your entire lesson.

It is necessary to convey to students that the rules of conduct in online classes are not much different from the rules in schools. You should be polite, respect yourself and others, not offend your interlocutors, and communicate pleasantly. Let them know that following these simple rules will allow them to better absorb the material of the lessons and make the distance learning process more efficient. Explain to students that following these rules is as necessary as following the rules of conduct in society. When starting online classes for the first time, draw up rules and discuss them with students. Be sure to take into account the opinions of students when drawing up the rules (Tünçeli,.2025). You can use the following examples when drawing up the rules. Rules for students in online classes: –Be polite. You should greet your classmates and teachers before starting the lesson, and say goodbye at the end.

Application of Web 2.0 technologies in online classes

The development of globalization processes requires certain changes in the content and organization of education. The basis of the change is the rapidly increasing flow of information. This growth is occurring at such a pace that the education system based on old methods can no longer cope with it. Increasing the volume of mastered knowledge leads to an excessive increase in the teaching load, negatively affects the health of the student, but does not give the desired results (Dash, 2024) Therefore, many experts believe that it is necessary to radically transform education, taking into account the current level of development of information technologies in connection with the processes taking place in the world. The basis of education is the interaction between people - teachers and students, as well as the students themselves

Information technology is a tool that can make this communication extremely effective. Information technology does not replace human communication - it allows you to focus on conceptual ideas by solving certain technical problems. The use of such technologies has wide possibilities.

Conclusion

The transition to online learning has fundamentally transformed the responsibilities of teachers and the structure of the teaching–learning process. Effective management of online classes requires not only subject knowledge but also strong organizational skills, technological competence, and awareness of students’ digital behavior. The study shows that discipline in online classes is best achieved through clear expectations, consistent teacher behavior, and respectful communication rather than punishment. Techniques such as using varied intonation, visual materials, short videos, interactive questioning, and planned micro-breaks help maintain students’ attention and prevent disengagement. Ensuring a distraction-free environment, using effective backgrounds, and providing feedback through chat further support the learning process.

Web 2.0 technologies play a crucial role in enriching online lessons by enabling collaboration, creativity, and student-centered learning. These tools help teachers move beyond traditional lecture formats and offer interactive, multimodal learning experiences. The integration of Web 2.0 tools also supports the development of digital literacy, which is essential in modern education. Overall, the study concludes that successful online teaching depends on the harmonious combination of pedagogical strategies and technological tools. When used thoughtfully, these approaches enhance communi-

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PHILOLOGICAL SCIENCES

LITANY OF LORETO (LITANIA LAURETANA) - THE FIRST GEORGIAN PRINTED PRAYER

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Abstract

Among humanity's intellectual achievements, the printing press, which was created in the 17th century, holds a special place. Even in the conditions of the global character of contemporary scientific-technical progress, the printed word remains the most flexible and comprehensive means of information. This is the characteristic that it has possessed at all stages of its development. Throughout the centuries, the printed word appears in the role of informer and educator, as well as an invaluable means of exchanging cultural values among peoples. This is also confirmed by the history of Georgian printed books.

The first Georgian printed publications are: "Georgian Alphabet with Prayers," "Georgian-Italian Dictionary," the Georgian translation of the Catholic prayer "Litania Lauretana," and Francesco-Maria Maggio's "Georgian Grammar." Despite the fact that "Litania Lauretana" is a Catholic prayer, it enjoyed no less popularity and respect among the Christian population of the entire Orthodox East. A review of the Georgian translation of "Litania Lauretana" allows for the unmistakable general conclusion that already in the 17th century, the printed word represented a quite effective weapon for achieving both political and religious purposes.

Keywords: printed publications, "Propaganda Fide," missionary activities, Catholic prayer.

Introduction: The establishment of the Georgian printed word and the initial stage of its development coincided with such a difficult historical period in our people's life when the possibility of implementing cultural measures in Georgia was almost excluded. Four centuries have passed since the first Georgian book was printed. This event was significant in the life of the Georgian people, who faced severe conditions of historical development. They had to take up the sword before they could take up the pen. It was precisely this circumstance that determined that the first Georgian printed books were printed outside Georgia's borders, in Italy, thereby laying the foundation for the centuries-old printing tradition of Georgian literature.

Among the measures implemented by the Roman Church at the beginning of the 17th century, one of the most significant was bringing missionary activities to the forefront. Papal authority used every means to acquire new congregants in Eastern countries through the spread of the Catholic faith. The idea of forming a central organ for Catholic missionary work was conceived as early as the 14th century, though only in 1622, during the time of Pope Gregory XV, was the society for propagating the Catholic faith, Sacra Congregatio de Propaganda Fide, created. In 1988, Pope John Paul II reorganized the Congregation, as a result of which it was transformed into the Congregation for the Evangelization of Peoples - Congregatio pro Gentium Evangelizatione. The organization's leaders tasked missionaries with studying the language of the country where they would have to work. For this purpose, appropriate literature was necessary - grammar books, dictionaries, the Bible, and other liturgical books. Naturally, "Propaganda Fide" faced the issue of providing this institution with its own printing press. In 1626, the decision was made to create a printing press, and its technical implementation was assigned to the renowned printer Stefano Paolini. In 1628, the Congregation made the decision to cast two types of Georgian fonts. An enormous amount of material about Georgia is preserved in the "Propaganda Fide" archive: missionaries write about Georgian culture, geography, and politics; the repository houses the correspondence between the Pope of Rome and Georgian kings.

Review and Discussion: The first Georgian printed publications are: "Georgian Alphabet with Prayers," "Georgian-Italian Dictionary," the Georgian translation of the Catholic prayer "Litania Lauretana," and Francesco-Maria Maggio's "Georgian Grammar."

In 1629, the first Georgian printed book, the "Georgian-Italian Dictionary," was published in Rome. The title page of this book states that it was compiled by Stefano Paolini with the assistance of the Georgian ambassador Nicephorus Irbach (Nikoloz Cholokashvili). This book contains up to three hundred Georgian words, the Georgian alphabet, and an index of Italian words.

In the same year, a second Georgian book, "Georgian Alphabet with Prayers," was printed in Rome. Several variants of this book exist: in one, the Italian title is given alongside the Georgian title of the prayer; in the other, it is not. In the 1614 edition of this collection, the prayer "Credo in unum Deum" ("I believe in one God") is presented in 20 different languages and dialects: Latin, Italian, French, Spanish, Portuguese, German, English, Irish, Dutch, Polish, Hungarian, Lithuanian, Welsh... This edition is preserved in the National Library of Paris.

In 1643 and 1670, the missionary Francesco-Maria Maggio published the "Grammar of the Georgian Language" twice, which he dedicated to Pope Urban VIII. The first part of the work is devoted to the grammatical rules of the Georgian or Iberian language; the second part to the rules of the Turkish (Arabic) language. Maggio's grammar of the "Georgian or Iberian

language" consists of four parts: Orthography, Etymology, Syntax, Prosody.

Maggio relies on the system of philological grammar and proceeds from the grammatical categories and processes of the Latin language. Despite all its shortcomings, Maggio's grammar holds a special place. Before Marie Brosset's "Georgian Grammar" came out (1834), European scholars became acquainted with the Georgian language through Francesco-Maria Maggio's grammar.

Printing books in Georgian in Europe had great significance. European missionaries became interested in Georgian culture. Additionally, the ground was being prepared for printing Georgian books in Georgia itself. The circumstance that the publication of the first Georgian printed books was carried out on an international basis deserves special attention. This fact indicates that in the 17th century, the printed word already represented a quite effective weapon for deepening international cultural relations.

A prayer to the Mother of God, "Litania Lauretana," translated from Latin into Georgian by Nicephorus Irbach (Nikoloz Cholokashvili), was also published in this religious institution's printing press. Let us try to understand what caused Nicephorus Irbach's so clearly manifested interest in "Litania Lauretana," that is, toward the Catholic prayer dedicated to the Mother of God. Or what specific circumstances facilitated his translation of this prayer into the Georgian language. Despite the fact that "Litania Lauretana" is a Catholic prayer, it belongs to that category of Christian prayers that enjoyed almost equal rights in both Catholic and Orthodox churches.

The missionaries initially went to Gori, which at this time was considered the citadel of missionary activities, then moved to western Georgia - to Samegrelo. Here, the missionaries performed the prayer to the Mother of God. A bell would ring as a sign of prayer, after which a secret prayer would be performed, and immediately the Litany of the Most Holy Mother of God would follow. Beyond doubt is the fact that "in the form of the Litany of the Most Holy Mother of God," "Litania Lauretana" is meant here, but not the Latin text of this prayer, but rather its Georgian translation published in Rome in 1629. The latter was brought to Georgia from Italy by missionaries in the 1630s along with the first Georgian printed books.

From the perspective of printing design, the external appearance of the Georgian text of "Litania Lauretana" is much more impressive than that of the "Alphabet" or the "Georgian-Italian Dictionary." Above the Georgian text of the Litany, inscribed in two lines, is a very distinctive decorated title, each component word of which is separated by three dots on the right. At the bottom of the sixtieth page of the Georgian text of the "Litany," below a drawn line, is an Italian inscription: "Printed in Rome, at the printing press of Propaganda Fide (Holy Congregation) with the permission of the highest ecclesiastical authority." The entire text - the Georgian translation of "Litania Lauretana" - is cast in an original, very beautiful ornamental frame. Its separately published Georgian text looks completely different, thanks to the impressive engraving. The engraving is the detail that crowns the prayer, which is placed above the title. The subject of the engraving is of biblical content. On it is presented with artistic refinement a composition whose central theme is the worship of the Mother of God to the newborn Christ in the presence of Saint Joseph, where the kneeling Mary humbly worships the newborn God-man, who lies on a white cloth spread on hay. On the left is given a fragment of the stable - with livestock, which announces Christ's birth in a stable, while on the right appear relatively distant figures of men who by their clothing resemble shepherds. Above the engraving, in the central part, is depicted a choir of angels in the rays of the sun, which contributes to the perception of the image imprinted on the engraving in its entirety.

The foundation of the "Litany," as a Catholic prayer, is sought in the content of the Old Testament of the Bible. The first recognized documentary information about the prayer itself is dated to 1531, 1547, and 1554, though officially it was confirmed only in 1587 by Pope Sixtus V. The most famous litanies are considered to be the so-called "Litany of All Saints" and the Litany of the Mother of God of Loreto, or "Litania Lauretana." From 1575 onward, other "new litanies" appeared, which is why the Vatican implemented a series of measures to protect the prayer from any violation, from the introduction of any changes and corrections to it. Apparently, such strictness of Catholic censorship determined that the text of the prayer has not undergone any significant changes over the centuries. To identify and characterize the inaccuracies allowed in the text of the Georgian translation of "Litania Lauretana" performed in 1629, it seems justified to compare it, first of all, with the corresponding Georgian text, which was published much later, in 1905 in Tbilisi, and which is still used by believing Georgian Catholics today. The latter in its content basically corresponds to the 1629 Georgian text of "Litania Lauretana," with the difference that instead of the Litany of the Mother of God of Loreto, it has as its title "Litany of the All-Holy," and the number of lines is not sixty but sixty-four.

Conclusion: A review of the Georgian translation of "Litania Lauretana" allows for the unmistakable general conclusion that already in the 17th century, the printed word represented a quite effective weapon for achieving both political and religious purposes. The possibility of using the printed word of that time for this purpose is confirmed by the joint participation of representatives of Italy, Greece, France, and Georgia in the publication of the first Georgian printed texts.

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CHANGES IN LANGUAGE ENVIRONMENT THROUGH THE INFLUENCE OF ABBREVIATIONS AND NEOLOGISMS

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Abstract

The rapid development of technology and the internet has significantly transformed the language environment. This transformation, driven by globalization and technological advancements, has led to the rise of abbreviations, neologisms, and slang, reflecting the evolving communication needs in a digital world. Neologisms, created to express new ideas and concepts, emerge from technological and cultural shifts and become integral to everyday language. This article examines the processes of socialization and lexicalization of neologisms and discusses challenges in translating these terms through methods like transliteration, calquing, and descriptive translation. Examples from digital technology, social media, and business highlight the dynamic nature of language and its adaptation to modern changes.

Keywords: language transformation, abbreviations, neologisms, digital communication, globalization, translation methods.

Today, the majority of the population in developed countries, as well as in developing countries, actively use social networks for entertainment and the internet for work. Globalization and the development of international trade contribute to the spread of languages of international communication in business processes, which, in turn, necessitates fast and concise communication. This stimulates the active use of abbreviations (acronyms) in written messages, helping people save time and effort while communicating.

In such communication processes, the vocabulary of the language becomes more complex because new words or expressions (neologisms) and slang are used, which must be understood by all participants in business relations or communication. Neologisms represent not just the addition of new terms but also a shift in cultural and linguistic attitudes. They reflect the ongoing evolution of society and the world, often indicating shifts in attitudes, values, and priorities.

Neologisms, as words or phrases, are created to denote new phenomena, objects, or concepts. They emerge in any sphere of life and are a natural process that reflects the development of language and adaptation to societal changes. The creation of neologisms is a direct response to the challenges presented by modern life, especially in fields such as technology, politics, and cultural shifts. The study of this issue is relevant for scholars such as Sh. Bally, A. Barer, G. Bauman, L. Bloomfield, V. Dord, Yu. Zatsny, K. Brovko, M. Halai. These scholars have contributed to understanding how new words and expressions evolve and become embedded in the language.

Neologisms are difficult to fix because they can appear situationally and exist for a certain period, reflecting emotional reactions of society to changes. They may remain as occasionalisms (words created by an author) and later be forgotten due to the decline in interest in a particular topic. If a neologism gains popularity, it becomes established in the language and is used in a specific field. Over time, neologisms that are widely accepted can undergo grammatical changes, becoming fully integrated into the lexicon of the language.

In translation practice, when it is impossible to find an adequate equivalent, methods of transliteration, transcription, calquing, or descriptive translation are applied. These methods help preserve the meaning and context of the original term while making it understandable to speakers of other languages. Translating neologisms requires a deep understanding of both the source and target languages, as well as cultural nuances.

A neologism goes through several stages of socialization (acceptance in society) and lexicalization (fixation in the language). When the topic is relevant, the word quickly becomes established, as it is used in everyday communication. The spread of new terms is often facilitated by the media, social networks, and popular culture, which act as catalysts in the process of lexicalization. As society adapts to new technologies and ideas, neologisms provide a practical means of describing new concepts, social changes, and innovations.

Examples of such neologisms include: flashmob: a combination of flash (moment) and mob (crowd), denoting a group of people gathering for a brief, spontaneous event; shopaholic: a person who is obsessed with shopping, often used humorously to describe someone with a compulsive need to shop; ageism: discrimination based on age, often related to prejudice against older or younger people in society; lookism: prejudice against a person based on their appearance, often related to discrimination in the workplace or in social situations; brexit: the UK's exit from the European Union, a term that became widely used to describe the political and economic consequences of the decision; bitcoin: cryptocurrency, a decentralized digital currency that allows for peer-to-peer transactions without a central authority; netbook: a compact laptop designed primarily for internet use, reflecting the increasing reliance on mobile computing.

In addition to the previously mentioned neologisms, the rapid technological advancements and changing societal norms continue to shape language in unique ways. New words are emerging regularly to describe the evolving realities of our digital and globalized world. Here are some additional examples of neologisms that have gained popularity: podcast is a digital audio or video file available for download or streaming, usually part of a series, offering a wide range of content from entertainment to education; unfriend means to remove someone from one's list of friends or contacts on social media platforms, indicating a decline in online relationships; binge-watch means to watch multiple episodes of a television series or an entire season in one sitting, often used in the context of streaming platforms like Netflix; selfie is a photograph taken of oneself, often with a smartphone or webcam, usually shared on social media platforms; crowdsourcing is the practice of obtaining information, ideas, or work from a large group of people, typically via the internet, often used in business, research, and innovation; meme is a humorous or viral piece of media, often an image or video, that spreads quickly across social networks, capturing popular trends or ideas; ghosting is the act of abruptly cutting off communication with someone, particularly in the context of dating or friendships, without explanation or notice; cryptocurrency is digital or virtual currency that relies on cryptography for security, such as Bitcoin or Ethereum, used as an alternative to traditional currency and many others.

These neologisms reflect how language evolves to meet the needs of modern society and technology. Whether they're created to describe new phenomena, behaviors, or tools, these words help us communicate effectively in an increasingly fast-paced and interconnected world. The adoption and popularization of these terms also serve as a social indicator of cultural shifts and emerging trends, demonstrating the ongoing adaptation of language to contemporary life.

The influence of technology, social media, and global communication has sped up the process of creating and disseminating neologisms. As these new words gain widespread use, they often become integrated into everyday language, illustrating the dynamic nature of modern communication and how language adapts to the evolving needs and experiences of society.

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EMBODIED CORE, CULTURAL FILTER: TOWARD AN INTEGRATED MODEL OF CONCEPTUAL METAPHOR

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Abstract

Conceptual Metaphor Theory (CMT) argues that metaphorical mappings from bodily (source) domains to abstract (target) domains structure much everyday thought. Early accounts emphasized an embodied universality of primary metaphors grounded in shared sensorimotor experience [1]. More recent cross-linguistic and anthropological work, however, documents systematic cultural variation in metaphor systems and proposes mechanisms by which culture shapes metaphorical realization [3,5]. This article critiques strict universalist and radical relativist positions and proposes an Embodied–Cultural Continuum: a layered model in which a sensorimotor-derived common core supplies cognitive affordances (primary metaphors) while cultural and discursive frames act as filters that select, elaborate, or reorient particular mappings. The model is illustrated by three case studies—TIME↔SPACE, emotion-as-container, and argument metaphors—drawing on cross-linguistic, corpus, and neurocognitive findings. Implications for semantics, translation, and second-language pedagogy are discussed. A concise research agenda recommends combining corpus analytics, neurocognitive methods, and ethnographic documentation to delineate the continuum's empirical boundaries.

Keywords: Conceptual Metaphor Theory; cultural variation; translation; corpus methods.

1. Introduction: universals and variation in metaphor theory

Since Metaphors We Live By, CMT has argued that metaphor is not merely rhetorical ornament but a central mechanism by which abstract domains are structured via mappings from embodied source domains (e.g., SPACE → TIME; UP → HAPPY) [1]. This embodied account explains recurring cross-linguistic regularities. Yet anthropological and cross-linguistic studies have shown that identical bodily constraints do not yield identical metaphor systems, provoking a debate between universalist and relativist readings of metaphor [3,5].

This paper defends a middle path. Embodiment provides possibility spaces—what humans can map—while culture and discourse determine which mappings become socially salient and conventionalized. The proposed Embodied–Cultural Continuum integrates primary-metaphor mechanisms with culturally sensitive, variationist principles, reconciling empirical regularities with documented divergences.

2. Theoretical framework: primary metaphors and cultural filters

Primary-metaphor research proposes that many conceptual mappings arise from recurring co-occurrences of sensorimotor experiences in infancy (e.g., AFFECTION IS WARMTH), which become entrenched as automatic mappings [2]. CMT's explanatory power increases when supplemented with an account of cultural selection: cultural schemas, environmental affordances, ritual practice, and discourse can highlight some mappings, suppress others, or reorient mapping directionality [3]. Kövecses 'notion of metaphor variation treats culture as an organizer that determines which bodily affordances are lexicalized and how they are exploited in conceptual systems [3].

The continuum therefore comprises two interacting layers: (a) a sensorimotor core of primary metaphors and neural predispositions; (b) cultural filters—historical, environmental, institutional, and discursive forces—that select, elaborate, or invert possible mappings.

3. Three case studies

3.1 Time ↔ Space. Space commonly serves as a source domain for time across languages, supporting that humans recruit spatial cognition for temporal reasoning [4]. However, mapping orientation differs cross-culturally. Many Western languages conceptualize the future as ahead and the past as behind (e.g., "looking forward"), whereas Aymara speakers position the past in front (visible/known) and the future behind (unknown), a divergence documented in both language and gesture [5]. This pattern exemplifies an embodied constraint (space as an available source) combined with cultural reorientation.

3.2 Emotions as containers. The BODY-AS-CONTAINER schema (EMOTION IS SUBSTANCE IN A CONTAINER) recurs widely. Nevertheless, cultures vary in which body part is salient as container (e.g., the heart in English; hara or belly-centered metaphors in Japanese), showing localization of a broadly shared schema [3]. Such variation is consistent with the continuum: the container metaphors arise from bodily experience, yet culture mediates the specific lexicalization.

3.3 Argument metaphors. ARGUMENT IS WAR is pervasive in many Western discourses (e.g., "defend your claim," "attack a position") [1]. Other societies foreground BUILDING, DANCE, or HEALING metaphors for disagreement and discussion, reflecting divergent rhetorical histories and social institutions. Since social metaphors depend less directly on primary sensorimotor mappings, they display greater cultural variability.

4. Empirical support and methods

Recent corpus studies and computational approaches quantify metaphor frequencies and distributions across large textual collections, corroborating both universal tendencies and systematic cultural differences and enabling the empirical mapping of the continuum [7,8]. Methodologies such as MIPVU support reliable manual annotation that complements automated detection pipelines [7,8]. Neurocognitive research indicates that metaphor processing recruits distributed networks—sensorimotor regions alongside semantic integration and control systems—suggesting biological constraints together with flexible control mechanisms that culture can shape [9]. A mixed-methods program (large-scale corpora; targeted neuroimaging contrasts between speakers of divergent metaphor systems; ethnographic recording of under-documented languages) is well suited to operationalize and test the continuum.

5. Implications

Semantics. The continuum challenges strictly truth-conditional, culture-indifferent accounts of lexical meaning: many lexical semantics are underwritten by socially conventionalized mappings grounded in embodiment. Understanding a term often requires access to its metaphorical mapping within a cultural ecology.

Translation. Literal lexical equivalence often fails for metaphors. Translators should aim for mapping equivalence: selecting target-language metaphors that instantiate comparable conceptual mappings and pragmatic effects rather than producing word-for-word renditions [6].

Second-Language Pedagogy. Explicit instruction in L2 metaphorical mappings—"metaphorical competence"—can mitigate negative transfer and improve pragmatic fluency, as learners often transfer L1 conceptual mappings into L2 contexts.

6. Conclusion and research agenda

The Embodied–Cultural Continuum integrates robust evidence of embodied regularities with documented cultural variation. To delineate the continuum's empirical boundaries I recommend three complementary steps: (1) large-scale, cross-linguistic corpus mapping of metaphor frequencies and orientations; (2) targeted neuroimaging comparing speakers of contrasting metaphor systems (e.g., Aymara vs. English) to test whether neural recruitment patterns vary with cultural mappings; (3) ethnographic documentation of metaphor usage in underdescribed languages to preserve and analyze alternative conceptualizations before global convergence accelerates. This mixed-methods agenda will clarify where embodiment constrains cognition and where culture sculpts conceptual landscapes.

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PHILOSOPHICAL SCIENCES

THE PROBLEM OF HUMAN SELF-IMPROVEMENT IN GOETHE'S TRAGEDY "FAUST"

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Abstract
The authors of this article refer to Goethe's tragedy "Faust" due to the current problems of Russian education, which is influenced by digital didactics. The result of this influence, according to the authors, is a decrease in interest in self-knowledge as the basis of human self-improvement. The teacher's task is to arouse students' interest in learning themselves and investigating their future. Goethe's Faust presents a solution to this problem. A person (student) must objectively assess the level of his intellectual and spiritual development, in fact, test his abilities. Both a person's mind and feelings are put to the test. A person's faith in God is also being tested. The uncertainty of the meaning of the word *God* (both as a concept and as an idea), which Faust and Margarita discuss, speaks to the uncertainty of human knowledge. The negative experience of Faust's life, who trusted Mephistopheles, speaks about the need for independence in human life. Faust strives for freedom, but underestimates the presence of a natural human trait – dependence, which appears to him in the form of Care. At the end of his life, Faust understands the meaning of human life and expresses it in the words: "Nur der verdient sich Freiheit wie das Leben, Der täglich sie erobern muß» [1]. For modern readers of the tragedy "Faust," knowledge of Faust's life experience serves as the basis for determining the path and ways to achieve their meaning in life.

Keywords: life, meaning of life, knowledge, reason, feeling

Addressing the problem of human self-improvement is especially important for a teacher. The change of the modern world, its values, and the way a person interacts with it affects most of all the formation of a new generation of young people. The teacher is faced with the task of finding new means and ways of interacting with students. The solution of these tasks depends on the activities of both the teacher and the student, on the ability of each of them to self–improvement and self-development - one of the most important resources of human education. It is no accident that we understand education as the process of a person gaining conscious independence in mastering the space and time of his life. But a person should have a desire to improve himself, to improve his life. The absence of it means the loss of the meaning of life, its end.

«Werd' ich beruhigt je mich auf ein Faulbett legen,
So sey es gleich um mich gethan!» [1].

But man, as the Lord says, is weak by nature:

«Des Menschen Thätigkeit kann allzu leicht erschlaffen,
Er liebt sich bald die unbedingte Ruh…» [1].

Peace is a natural inclination of a person, and the acquired one is associated with his conscious activity, with human activity. And to awaken this activity, the Lord makes Faust's companion a demon, who teases him and stirs him up to action.

Human education is also a matter of concern. And the task of the teacher is to awaken in the student an interest in learning not only about the outside world, but also about himself. Self-knowledge serves as the basis for self-improvement. It is with the characterization of Faust's self-knowledge that our acquaintance with him begins:

"Habe nun, ach! Philosophie,
Juristerey und Medicin,
Und leider auch Theologie!
Durchaus studirt, mit heißem Bemühn.
Da steh' ich nun, ich armer Thor!
Und bin so klug als wie zuvor…» [1].

Faust also negatively evaluates himself as a teacher:

"Die Menschen zu bessern und zu bekehren.
Auch hab' ich weder Gut noch Geld…» [1].

And this self-assessment of Faust leads him to study magic as another way of knowing the world:

"Drum hab' ich mich der Magie ergeben,
Ob mir durch Geistes Kraft und Mund…» [1].

However, the new method of cognition by itself does not guarantee knowledge of the mysteries of nature and man. I need to test my abilities. That is why Faust says:

"Ich ehle Muth, mich in die Welt zu wagen,
Der Erde Weh, der Erde Glück zu tragen,
Mit Stürmen mich herumzuschlagen,
Und in des Schiffbruchs Knirschen nicht zu zagen…» [1].

And then Faust says that the time has come to prove by deeds that human dignity is not inferior to the greatness of the gods:

«Hier ist es Zeit durch Thaten zu beweisen,
Daß Mannes-Würde nicht der Götterhöhe weicht…» [1].

Proof by deed is the right way to self–knowledge, to test a person's readiness for independent living, but the price of such self-knowledge is human life. And on this path, new challenges await a person, which not everyone can withstand. One of the universal tests is faith in God. And Faust, answering Margarita's question "Don't you believe?"[2], says:

«Nenn' es dann wie du willst,
Nenn's Glück! Herz! Liebe! Gott!
Ich habe keinen Nahmen Dafür! Gefühl ist alles;
Name ist Schall und Rauch,
Umnebelnd Himmelsgluth»

In response, Margarita exclaims:

"Das ist alles recht schön und gut..." [1].

Awareness of uncertainty turns out to be a boon for Margarita. The uncertainty of the meaning of words denoting the idea of love, beauty, soul and other similar words is inherent in human knowledge today. But do we perceive this kind of uncertainty as a blessing today? And what is the measure of the ratio of certainty and uncertainty in human cognition and human education today? The search for answers to these questions is one of the foundations of a person's self-knowledge and self-improvement.

The result of self-knowledge is a person's assessment of his actions. And Faust condemns himself for his attitude towards Margarita. The ordeal of mental anguish and suffering falls to the lot of Faust and Margarita. And Margarita prefers death to a shameful life. Faust and Mephistopheles leave her world. Faust acquired such a negative life experience in collaboration with Mephistopheles. And the reason for this result was Faust's loss of the independence of his actions, his appeal to magic. In his life path, a person encounters Vice, Sin, Care and Need. And Goethe gives them all a negative image of "ill-fated visions" [2] as Faust puts it. After meeting them, Faust realizes his dependence on them:

"Noch hab' ich mich in's Freie nicht gekampft.
Könnt' ich Magie von meinem Pfad entfernen,
Die Zaubersprüche ganz und gar verlernen,
Stünd' ich, Natur! vor dir ein Mann allein,
Da wär's der Mühe werth ein Mensch zu seyn» [1].

Left alone with Care, Faust defends his right to be free:

"Doch deine Macht, o Sorge, schleichend groß,
Ich werde sie nicht anerkennen» [1].

However, taking care of yourself and your loved ones is a natural human trait. With our soul, we worry about the lives of other people, for their better future. Faust says the same thing, summing up his life:

"Ja! diesem Sinne bin ich ganz ergeben,
Das ist der Weisheit letzter Schluß:
Nur der verdient sich Freiheit wie das Leben,
Der täglich sie erobern muß» [1].

With this statement Faust defines the meaning of human life. Summing up our acquaintance with Faust's life, we ask ourselves about the origins of his activity, about his desire for a full-fledged life, the life of the human mind and feelings. And we assign the defining role in Faust's life to the life of his feelings. Perhaps our conclusion was influenced by the form of the work – a tragedy, the content of which is a test of a person, his ability to live a decent life. Perhaps S. Turaev, a Soviet researcher of Goethe's work, is right speaking about the role of feelings in the work of writers of the Enlightenment: "... For European writers of the second half of the XVIII century, feeling was the banner of the struggle against cruelty, callousness, and soullessness that prevailed in feudal society. It was a struggle for man, for his multifaceted development" [2, p. 10]. Today, we are concerned about the importance of the role of feelings in the education of a person in the 21st century, about achieving harmony in the interaction of his feelings and mind. And Faust's life path, his critical attitude to his achievements, the search for ways of his development, and the meaning of life serve as the basis for solving the problems of modern human education.

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SOCIAL SCIENCIES

QUALITY ASSURANCE IN SERVICES FOR PERSONS WITH INTELLECTUAL DISABILITIES: EVALUATING EQUASS APPLICATION IN DAY CENTRES

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Abstract

The article examines the application of the EQUASS quality standard and its impact on day centres providing services for individuals with intellectual disabilities. The study sought to determine how the implementation of EQUASS influences the activities of service users and what professional changes are observed by social workers. A qualitative analysis was conducted using semi-structured interviews with social workers, highlighting a client-centred approach that involves service users in decision-making, enhances professional well-being, and fosters leadership. The findings indicate that the standard has promoted improved communication through visual tools, strengthened the culture of teamwork, and led to a significant enhancement in service quality. It is emphasised that the EQUASS quality standard contributes to ensuring the social inclusion of persons with disabilities and increases their independence.

Keywords: intellectual disability, day centre, EQUASS standard, quality of social services, social worker, service user.

Introduction. The increasing expectations of social service users and society towards public sector organisations encourage these institutions to adapt, respond to new challenges, and strive for continuous improvement in the quality of their services (1). Adomaityte-Subacienė (2) state that this requires the development of robust management and assurance systems, as well as the establishment of standards. The growing scope of social services and the paradigm of new public management have firmly embedded the concept of quality within the field of social service provision. Ginaviciene et. al (3) argues that for service-providing institutions, it is essential to formulate quality objectives in order to ensure their implementation, basing decisions on evidence, continuous improvement, and a client-oriented approach that addresses the needs of service users. According to Adomaityte-Subacienė (2), the standardisation of services is one of the means of guaranteeing the effective delivery of high-quality social services.

In Lithuania, several quality standardisation systems are in operation: at the national level, the description of Social care standart (4) has been regarded as the quality standard for services; additionally, the international EQUASS quality assurance system is applied on a voluntary basis, alongside NOKAS, a quality standard developed by non-governmental organisations.

One of the objectives of the EQUASS quality system is to involve employees in the processes of quality improvement and continuous development, while ensuring that service users participate in the implementation of the quality system and receive high-quality services (5). In the development of social service quality systems, quality assessment indicators constitute a fundamental element, which is subject to ongoing debate in the search for the most appropriate measures to reflect quality. Adomaityte-Subacienė (2) and Ciapaite (6) have examined the recommended principles and criteria for the provision of social services in pursuit of high-quality outcomes, both emphasising that the indicator of social service quality should not be understood as a final result, but rather as oriented towards the very process of service delivery. This study addresses the following research questions: (1) How does the implementation of the EQUASS quality standard transform the activities of social service users in day centres? (2) What professional changes are observed by social workers following the introduction of the EQUASS quality standard in these institutions?

Methodology. Research Methods:

The research employed two methods: analysis of scientific literature and a qualitative research approach. For qualitative data collection, semi-structured interviews were conducted using a prepared questionnaire. **Sample Characteristics:** The study population consisted of social workers employed in day centres providing social services to individuals with intellectual disabilities, each with a minimum of three years of professional experience. A total of 11 respondents participated in the study. The average professional experience among participants was 13 years. All respondents were women. The research was conducted in accordance with ethical principles characteristic of qualitative studies. **Data Analysis Method:** The data were analysed using content analysis, which was considered the most appropriate method for the detailed examination and interpretation of the responses. The analysis followed the methodology proposed by Zydziunaite (7):

1. Reading the interview transcripts to identify the main aspects;
2. Segmenting the text and formulating individual statements;
3. Identifying significant elements;
4. Developing categories;
5. Forming subcategories.

In the study "Quality assurance in services for persons with intellectual disabilities: evaluating EQUASS application in day centres", two principal themes were distinguished:

- **First theme**: service users' rights and responsibilities, the benefits of collaboration with organisations, and the involvement of service users in service organisation.
- **Second theme**: promotion of personal leadership, enhancement of professional competence, and employee motivation.

The results were systematically analysed and compared with data from other scholarly sources to ensure the reliability of interpretation and theoretical grounding.

The **first theme** – "Expansion of Service Users' Participation Opportunities under the EQUASS Standard" – was divided into three categories and nine subcategories. The results of the first theme are presented in Table 1.

Table 1.

Expansion of Service Users' Participation Opportunities under the EQUASS Standard

Category	Subcategory	Empirical Statement
Service users' rights and responsibilities	**Right to privacy**	*"In order to safeguard personal privacy, the institution provides a designated space intended primarily for rest and relaxation; service users are aware that, whenever necessary, they may withdraw there to enjoy tranquillity."* *"Without exception, all matters of hygiene are conducted in strict observance of privacy, while also taking into account the preferences of service users regarding particular private concerns."* *"There are occasions when a service user wishes to spend time alone in peace. Regrettably, the institution does not possess a separate room for this purpose; nevertheless, respect for this individual right is ensured by making use of a more secluded area with fewer stimuli, which serves the need effectively."*
	Right to self-expression	*"Within the institution, the right to self-expression is actively encouraged; in all activities individuals are supported in being themselves, with due regard to their personal abilities, and on more than one occasion they have surprised us."* *"When discussing the rights of service users, it is important to emphasise that their capacities and desire for self-expression are particularly evident in creative activities."*
	Visual tools	*"Following the introduction of EQUASS, a considerable number of illustrated materials were developed, including various posters; moreover, internal regulations were set out both in written form and through specific pictorial representations. All of this is undertaken to ensure comprehensibility for service users."* *"With the implementation of EQUASS, a large interactive board was introduced, displaying an image for each activity, so that individuals who are unable to read may independently select their preferred activities. Experience demonstrates that service users themselves appreciate the significance of this board."*
Collaboration with Organisations	**Inclusion**	*"Naturally, service users are pleased to be included in such initiatives"* *"It is important to involve them, to provide opportunities for participation; <...> often, owing to disabilities, they have few occasions to go out, and here it is so aptly referred to as 'partnership'."* *"Collaboration itself is highly inclusive of service users; they tend to be genuinely interested and motivated, and often require no encouragement at all."*
	Voluntary participation	*"It is most gratifying that, having taken part once, the majority of service users remain satisfied and eagerly anticipate such activities again."* *"At times, disagreements even arise among individuals over who will participate on a given occasion, as they enjoy it so much."* *"Initially, some motivation was required; however, now that the partners are regular and consistent, service users have become accustomed to the activities and participate very willingly."*

Involvement in Service organisation	**Contribution of staff**	*"We always make efforts to involve individuals as much as possible." "It is of great importance that staff themselves strive to engage service users. It seems that prior to the introduction of EQUASS this was not emphasised to the same extent, whereas now we aim to ensure that everything is carried out with their involvement. <...> This, of course, requires considerable personal responsibility and patience on the part of staff."*
	Submission of suggestions	*"With regard to the submission of suggestions by service users, even prior to the application of EQUASS our institution took their proposals into account, although now we place greater emphasis on encouraging them to submit such suggestions." "Service users are familiar with the procedure by which they may submit suggestions; moreover, we encourage their representatives to become involved, to collaborate, and likewise, if they have proposals, they may freely present them."*
	Freedom of choice	*"When selecting the activities in which a service user would most like to participate, complete freedom is granted. <...>. Although it often happens that an individual is talented and enjoys many activities, prior to drawing up the schedule we always allow them to choose." "You know, the very awareness that one has the right to choose—even if in reality the difference between activities is not very great—serves as an encouragement; it enables them to feel important."*
	Service User's Opinion	*"Personally, I very much appreciate that nowadays individual wishes and opinions are always taken into account. Previously, most matters tended to be decided more by staff, whereas now we always approach the person, ask in which activity they would like to realise themselves, what they enjoy and what they do not. No longer is it the case that they must simply accept the staff's decision."*

The EQUASS standard emphasises the safeguarding of service users' rights within institutions and encourages service providers to create appropriate conditions for the realisation of these rights. The data reveal that service users are aware of their responsibilities and adhere to them. Respondents identified the use of various visual aids as one of the benefits of EQUASS. Raudeliunaite et.al (8) argues that signs, illustrations, and other visual tools are easier to comprehend than text, which is particularly important given that, due to their disabilities, service users often cannot read or may even be non-verbal. Participation of persons with disabilities in social life is a key objective, achieved through diverse inclusion measures (9). Despite efforts to promote inclusion, stigma and prejudice against people with disabilities persist. To address this effectively, it is essential to organise partnerships that motivate and provide opportunities for service users to participate actively. Respondents highlighted that when attending activities in similar institutions, service users not only establish friendships but sometimes form long-term social bonds. Another positive aspect of EQUASS identified by the study participants is its strong orientation towards the service user. Staff are required to ensure that individuals are as actively involved in processes as possible. Social services must be delivered flexibly, taking into account the abilities, needs, and preferences of service users (2). The EQUASS model stipulates that individuals should be included in the planning, provision, and evaluation of services. Accordingly, institutions must guarantee opportunities for service users to contribute suggestions. By involving service users in service organisation, employees themselves become more engaged, as such involvement gives greater meaning to their work. Raudeliunaite et. al (8) emphasise that the provision of high-quality social services requires attention not only to the final outcome but also to the process itself, ensuring that service users are included and their suggestions considered. A significant contribution to the improvement of individuals' quality of life is the freedom granted to them to express their opinions Beneseviciute (10). Study participants also highlighted the importance of this freedom in achieving a more effective user-centred orientation. Geciene (1) argues that, according to the principles defining quality, the EQUASS model is particularly suitable for institutions providing rehabilitation, where considerable attention is devoted to meeting service users' expectations and needs. The findings of this study confirm this assertion.

The **second theme** – "Changes in Social Workers' Professional Practice under the EQUASS Standard"– is divided into three categories and six subcategories. The results of this theme are presented in Table 2.

Table 2.

Changes in Social Workers' Professional Practice under the EQUASS Standard

Category	Subcategory	Empirical Statement
Encouragement of Personal	**Leadership – Interpersonal Relations**	*"It is important that relationships among colleagues remain friendly and free from personal grievances, so as to avoid unnecessary disputes or disagreements."* *"We must support and assist one another. I believe it is essential to show attention and care towards colleagues, demonstrating that they matter to us. In this way, we can effectively strive for the provision of high-quality services."* *"Colleagues consistently encourage one another and provide strong support when personal development is being pursued."*
	Encouragements	*"With the introduction of EQUASS, leadership has been increasingly promoted. This is evident among colleagues, and the encouragements are now more individualised. Moreover, recognition and encouragement from management have become more frequent, clearly reflecting a collective aspiration towards improvement."* *"I have truly noticed a change. The administration is invested in us striving for something more. You see, it is implemented not through compulsion, but through the idea that it is not that we must strive for more, but rather that we choose to strive for more."*
Strengthening Professional Competences	**Freedom of Choice**	*"I appreciate that nowadays there are no longer only general seminars for the entire institution; instead, we ourselves select the training sessions that are organised and of interest to us."* *"Previously, the institution would order training and we would all attend. Even if the information was already familiar to us, it was not particularly useful, and we gained little from such sessions. Now we look at what appeals to us, since we ourselves understand which competences we lack, <...> experiences differ among everyone."*
	Need for New Knowledge	*"In working with service users who have such diverse and individual needs, it often becomes necessary to refresh existing knowledge and to be able to apply it in specific situations. It is important to recognise where knowledge is lacking and to strive to improve it."*
Employee Motivation	**Achievement of Set Goals**	*"For me personally, professional motivation is most enhanced by the service users' achievements, even if small, provided they are visible and tangible."* *"Work motivation is greatly strengthened when the goals set together with the service user are successfully achieved, or even surpassed. <...> In such cases, professional activity acquires deeper meaning and motivates us to set higher objectives in relation to service users. <...> This is particularly evident now, with EQUASS, as we pay close attention to the client's opinion."* *"In my view, no further incentives are needed; when one sees that a shared goal has been fulfilled, it is highly motivating—more so than any bonuses or gifts."*
	Shared leisure time with colleagues	*"It is enjoyable to meet colleagues outside the work environment; we spend much time together at work, and such gatherings greatly strengthen our bond."* *"Sometimes we meet for coffee after work, not to discuss work matters, but simply to get to know one another better."* *"I am not sure whether this is linked to EQUASS, but recently we have begun such informal gatherings. <...> Perhaps this is related to the greater encouragement of leadership and the fostering of friendly relations among colleagues."*

One of the fundamental principles of the EQUASS model is leadership. Minelgaite et al. (11) argue that leadership, as a factor, is highly significant for employee well-being and institutional performance outcomes. Its importance often lies not so much with the leader themselves, but with their followers – colleagues. The employees who participated in this study emphasised that interpersonal relationships among staff play a crucial role in fostering leadership. In order to create a favourable workplace climate, positive relationships between employees are essential notes Juodisiute (12). The findings also highlight that, thanks to EQUASS, staff receive more encouragement from the administration. Professional well-being and personal development of social service providers are fur-

ther enhanced through training and competence-building. Abromaitiene (13) found that participation in supervision sessions enables employees to respond more calmly to emerging problems, strengthens collegial relationships, and reshapes perspectives on certain situations and their own roles within them. Naujaniene et. al (14) note that for social workers, supervision is important for professional improvement, enhancing relationships with colleagues, and reducing the risk of occupational burnout. Study participants also stressed the significance of the choice introduced through the EQUASS model. Staff training and seminars serve as tools for improving competences, developing personal qualities, and giving greater meaning to professional activity. Abromaitiene (13) further observed that continuous professional development contributes substantially to reducing stress and tension in the workplace. As previously noted, the field of social work is broad and dynamic; therefore, according to Griciute et al. (15), it is vital for social workers to remain motivated and competent, enabling them to adapt to change, perform tasks more efficiently, and acquire new knowledge. An essential factor identified during the study as enhancing employee motivation is the achievement of set goals. In order to motivate social service providers, attention should be paid to enabling individuals to meet their own needs, while at the same time employing measures that contribute to the attainment of the organisation's collective objectives. More broadly, employees should be encouraged to develop their professional capacities as fully as possible, with favourable conditions provided for personal growth. Motivational measures are not static; they may change depending on circumstances or over time, as individual needs also evolve notes Nikolajenko (16).

It was further noted that shared leisure activities with colleagues help to reduce tension and improve interpersonal relationships. By spending time together, employees strengthen their mutual bonds and foster a stronger sense of teamwork. The analysis of research data revealed that time spent with colleagues is highly valued by staff. Bubnys et al. (17) support this view, emphasising that interpersonal relationships among employees are directly linked to job satisfaction. Such gatherings provide opportunities for staff to relax, detach from work-related problems, and gain a deeper understanding of one another.

Conclusions. The results of the study revealed that the implementation of the EQUASS quality standard in day centres providing services for persons with intellectual disabilities has led to significant changes related to service user involvement, the improvement of organisational processes, and the professional well-being of staff. Institutions have become more oriented towards the needs, opinions, and suggestions of service users. Decision-making, which previously tended to be carried out on behalf of the service user, has been transformed into a model of partnership, whereby decisions are made only after consultation with the service user. In order to achieve clearer communication and greater involvement, various visual tools have been introduced to present activity schedules, service users' rights, and general behavioural rules in an accessible manner. Such changes strengthen the autonomy of persons with intellectual disabilities, increase their participation in service planning and organisation, and promote social inclusion.

At the organisational level, the implementation of EQUASS has encouraged more consistent planning, evaluation, and organisation of services, oriented towards concrete outcomes and their continuous improvement. Leadership promotion has been strengthened, greater attention is devoted to professional development, and new opportunities have emerged for competence-building tailored to individual staff needs. This enables the targeted strengthening of missing competences and the deepening of existing knowledge, thereby enhancing professional satisfaction and efficiency. The culture of teamwork has also been significantly reinforced, with staff more frequently initiating joint projects and engaging in collaborative decision-making. The findings further indicate that professional well-being is most strongly supported by collegial relationships and managerial encouragement for achieved results, although for some respondents the primary source of motivation remains the achievements of service users and the successful attainment of shared goals. The organisation of shared leisure activities with colleagues was identified as an important means of maintaining psychological well-being and reducing stress. Moreover, more active collaboration with social partners has increased institutional visibility within society and contributed to the strengthening of inclusion for persons with intellectual disabilities. The implementation of the EQUASS quality standard has fundamentally reinforced the orientation of institutions towards service users, stimulated the professionalisation of organisational processes, strengthened teamwork, and enhanced the professional well-being of staff. The standard has become an important instrument for the continuous improvement of service quality, the promotion of autonomy among persons with intellectual disabilities, and the assurance of their full social inclusion.

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TECHNICAL SCIENCES

EVALUATION OF THE DRAFT COMPETENCE STANDARDS FOR REMOTE-CONTROL VESSEL OPERATORS AND THEIR FUTURE IMPLEMENTATION IN MARITIME EDUCATION

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Abstract

The application and advancement of remote control and autonomous functions in the shipping business has already begun and will increase in the coming years. Remote control functions can be defined as such functions that allow a human operator, while being in a land-based location, to monitor and remotely exercise control over the operations of a given vessel. Currently, there are no IMO instruments that regulate the commercial remote-controlled vessels, nor the technical requirements behind this concept. A safety framework will be necessary to standardize the requirements for unmanned vessels or those with reduced crew. To achieve vessel operation at an equivalent level of safety, remote-control operators must have appropriate competences. However, competence standards for operators have not yet been developed and standardized. The aim of this article is to research and evaluate the progress of various organizations to prepare draft competence standards for supervisors and remote-control operators for maritime and inland navigation and how these standards can be implemented in maritime education. The research methodology employed in this study involved a thorough document analysis of relevant industry reports, guidelines, and documents.

Keywords: remote-controlled vessels; autonomous shipping; unmanned ships; maritime safety framework; competence standards.

Introduction

Shipping plays a major role in maintaining world trade, with over 50 thousand vessels to transport commodities, equating to more than 60 trillion ton-miles internationally (ICS 2022). Skilled and experienced seafarers are an essential part of the stability and safety of shipping. Currently, there are over 1.6 million seafarers worldwide, including 774 thousand officers (ICS 2022). The COVID-19 pandemic has highlighted the importance of seafarers in maintaining the supply chain, while the crew change restrictions caused a significant upset in the shipping industry. The International Maritime Organization (IMO) has recognized the necessity and growing demand of seafarers and encourages governments to treat them as "key workers" who conduct an "essential service" (IMO 2020).

However, human error or the so-called “human factor” remains a critical issue affecting the industry, with over 80% of marine accidents being caused by human-related failures [4]. The psychological strain is one of the crucial factors that invites errors. When the strain becomes too much, decision-making is induced, which causes safety considerations [9]). Excessive psychological burden, also known as "stress," causes fatigue that may affect ship safety significantly (IMO 2019). Ship automation and remote control have emerged as solutions to tackle the problem. The contemporary development of information and communication technology, including computation and artificial intelligence, has inevitably led to the emergence of Maritime Autonomous Surface Ships (MASS). The shipping industry has seen the development of MASS for several years. For instance, in 2018, Finferries and Rolls-Royce demonstrated an autonomous ship (Rolls-Royce 2018), while a new demonstration project has been initiated by the Nippon Foundation with the goal of promoting unmanned commercial ships, which are expected to be operational by 2025 (NYK 2020). In addition, Yara International plans to operate a completely unmanned commercial ship in Norway (Maritime Executive 2021).

Although the autonomous capabilities of MASS are extensive, different organizations, such as Lloyd's Register, Maritime UK, and IMO, classify them in various ways. The most advanced level of autonomy, where a ship can operate independently without human supervision, may not be achieved soon because of serious concerns related to safety and security. As the fully autonomous level is unlikely to be addressed in the near future, the remote-control center and remote operator as part of the shore-based infrastructure for ship control will play a vital role in the MASS system [15]. However, international regulatory requirements for RO competence have not been introduced yet, and this presents a challenge.

The implementation of autonomous and remote shipping is expected to cause significant disruptions and challenges in the manning sector, which in turn will require a thorough re-examination of the training frameworks within the maritime industry [1]. Despite the absence of regulatory guidelines, the development of autonomous and remote fleets has not halted, resulting in the emergence of a new profession: the remote operator. The Remote Operator is accountable for ensuring the safe navigation of autonomous vessels from a Remote Operations Center, either through monitoring or direct control. It is possible for deck officers to transition to this new role, but the specific skills and training necessary for this shift have yet to be determined.

The operator, stationed in the shore-based command center, would be responsible for navigating the ship and supervising the full operational parameters surrounding the everyday vessel tasks. It is generally agreed that the operator must possess specialized skills for the job, although there is currently no clear consensus on what these skills entail or how to train remote-control operators. Two possibilities for the development of this position exist: it could involve the "occupational progression" of a seafarer from a ship-based role to a shore-based position, or the creation of new job opportunities for new hires [12].

The operator should be able to perform the same range of tasks as an equivalent deck officer, if those tasks have not already been automated. With the advent of remote operations, it is natural for seagoing deck officers to become Remote Operators responsible for safe navigation remotely. Any MASS remote-control operator should be able to perform these tasks as efficiently and safely as the current team of deck officers [3].

The primary objective of this article is to investigate the ongoing advancements undertaken by a multitude of organizations with the express purpose of developing and formulating preliminary drafts of competence standards specifically tailored for supervisors and remote-control operators operating in maritime and inland navigation. Additionally, this article seeks to bring forward the complexities surrounding the practical implementation of these standards within the domain of maritime education. In order to accomplish these research objectives, the chosen research methodology employed in this study encompassed an exhaustive document analysis of a wide array of pertinent resources, including industry reports, guidelines, and an extensive collection of documents curated from the shipping industry. Through this systematic approach, the research team aimed to gain insights and a comprehensive understanding of the current state and progress of competence standards development within the dynamic and evolving sphere of remote control and autonomous functions in the shipping industry.

Literature survey

The subject of automation in ships was first addressed by the IMO during the 8th session of the Maritime Safety Committee in March 1964 [7]. As the development and continuous improvement of ship automation have been expanding, the maritime sector is expecting the operation of MASS to be implemented in the near future based on technological advancements. Numerous research projects on MASS have been conducted and are currently ongoing globally, such as the DNV-GL Revolt [17], Kongsberg Maritime Autonomous Shipping, and NYK Maritime Autonomous Surface Ships Trial.

The complex nature of MASS operation and new technologies have presented multiple challenges for the various research projects. In response, the IMO has undertaken a MASS regulatory scoping exercise (RSE) (IMO 2017) aimed at identifying and addressing these issues, while also accommodating technological advancements in the field of MASS (IMO 2018). Another target for the RSE is to assess the impact of autonomy on regulatory frameworks and identify any necessary changes to enable the safe operation of MASSs.

In order to prepare for the future of MASS, deck officers need to be trained in all levels of autonomy, whether they are working on board a vessel or as a remote operator on shore. One solution could be to include these aspects in the STCW competency level courses, as well as providing separate training for officers who plan to transition to the role of remote operator. IMO recognizes that many of its current rules and regulations are not suitable for MASS, as they were developed with conventionally manned ships in mind [12].

In his work, Ramos et al. has provided background on the challenges that operators of MASSs may face, irrespective of their location. Such challenges include information overload, situational awareness, skill degradation, and boredom [14]. On a related note, Nava and Fernanda [13] argued that legal issues regarding liability for collisions must also be considered when developing specific regulations for autonomous and unmanned vessels under the STCW convention, including the UNCLOS, COLREG, and STCW 1978 convention.

Seven skills were identified as very important, in order for the vessel remote-control system to run smoothly: Seamanship, Well-trained and multi-skilled, IT and cyber security literacy, Tool Handling, Communication, Safety awareness, Emergency response [10]. Elaboration of many of these skills is needed to determine the necessary experience and training required to support them. It is evident that both technical and non-technical skills must be integrated into the operator training. Some skills may be acquired through shore-based training by non-seafarers, while others may require practical sea experience, albeit of a shorter duration. Some of the above skills may demand both seafaring experience and training before an operator can assume control of a vessel (IMO 2018).

According to a study on the competency requirements of future seafarers, it is anticipated that some skills will remain essential, but their modified versions will be in higher demand. These skills include critical thinking and quantitative reasoning, technical literacy with a focus on information and communication technology, and environmental sustainability. Additionally, the study highlights the likelihood of the emergence of new knowledge and competencies, such as technological awareness, computing and information skills, learning and self-development, as well as adaptability and flexibility.

In his work, Emad et al. [5] has interviewed key stakeholders in the maritime industry and has concluded that both current and new skills will be needed to operate autonomous ships. Operators should first undergo traditional seafaring training before being upskilled to work with autonomous ships and shore-based stations. In addition, it has been found that the Maritime Education and Training (MET) institutes are currently unprepared to impart the necessary skills and competencies that would be required by future seafarers, primarily because the technology for autonomous ships is still being developed. Therefore, preparations for the future are being impeded due to the uncertainties surrounding technological advancement. Yoshida et al.

have proposed a method for establishing regulatory requirements for seafarers' competence based on ship awareness and can be applied to evaluate regulatory requirements for new MASS [18]. Additionally, the study's results can serve as a foundation for introducing a blend of competence requirements, training for officials, and advanced technology for MASS.

According to Hannaford et al., many deck officers reinforce the belief that shipping companies, unions, and MET facilities are not adequately prepared for the industry's changes. Many survey participants believe that MET will significantly change within the next decade [8]. Another article concludes that the maritime industry needs to reform its education and training methods to prepare seafarers for the future workplace as the shipping industry shifts towards technology-based systems. Additionally, there is a possibility that decentralized education systems will emerge in the industry, including specialized courses and continuous professional development [6]. The survey conducted by Alice et al. resulted in the conclusion that the skills and experience gained at sea are crucial for remote operators, but current training and certification are inadequate for operating autonomous vessels. The current STCW training is not suitable for Industry 4.0, as it lacks skills in cyber security and understanding AI systems [12].

Training needs to evolve to support a more versatile and technical approach and although the Netherlands has combined deck and engineer training courses, this approach might not be sufficient for remote operators or deck officers working with autonomous vessels. To keep up with emerging technologies, training needs to be adaptable and cater to the changing needs of the industry. Nevertheless, the industry is changing rapidly, and the current slow implementation of changes is inadequate. The STCW OOW syllabus must be updated to include training and standards for officers working on autonomous and remote-control vessels, as well as standards for remote-control operators. With the development of MASS fleets in the upcoming years, it is highly likely that conventional vessels will have to interact with MASS. Up to date education and training that encompasses modern vessels and trends will provide opportunities for deck officers interested in exploring the MASS sector.

The first step towards preparing deck officers for the maritime industry's future should be updating the STCW training framework. However, regulatory bodies play a critical role in maintaining international competency standards. Practical onboard training will be critical for remote operators to become familiar with vessels and sailing areas and maintain their skills and experience. Simulation training will also prove useful in preparing remote operators to adapt to a new environment and become comfortable with the user interface. In that regard, type-specific console courses must be established to address the software and potential hardware differences between the remote-control stations of various manufacturers.

Progress in competence standards for remote control operators

DNV, a classification society based in Norway, has introduced in Nov. 2021 the first competence standard for operators of ship remote control centers (RCC) along with a recommended practice for a certification scheme. This framework aims to establish guidelines for the training, evaluation, and certification of RCC employees who operate or support operations at sea through remote-control facilities. In collaboration with Kongsberg Maritime, Wilhelmsen, the University of South-Eastern Norway, and the Norwegian Maritime Authority, DNV has developed two new standards. The first standard is DNV-RP-0323, which guides the RCC operator examination process and acts as the certification body for granting personnel certificates. It also includes a competence-building process for candidates before taking the RCC operator examination. In addition, the establishment of the foundation for the entire autonomous vessel management procedure and the identification of essential skills are outlined in the DNV SeaSkill standard ST-0324 (DNV 2021).

Kari et al. conducted a study that developed a remote supervisory control prototype for unmanned cargo vessels and invited six participants with sea experience to conduct scenario-based simulation trials as proposed by SCC operators [11]. The study found that using commonly used navigational and collision avoidance technologies in a different way could lead to problems in developing sufficient situation awareness for remote supervisory control tasks. Without adapting the tools to the domain constraints of shore-based remote monitoring and controlling tasks, it was hard for the operators to perform the tasks reliably. Decision-making latencies and automation bias were observed.

In the inland water transport (IWT) sector PLATINA3 Policy Platform has published a Report on competences needed to operate on board systems allowing for automation of inland navigation vessels D3.3. As per the report, the emergence of remotely operated vessels has created a need for new competencies, particularly for nautical inland shipping personnel involved in remote operations. Existing initiatives are advancing from national to cross-border operations, highlighting the need for new competence standards.

Currently, IWT operations are single-vessel based, with remote control from a shore control center and support from an experienced boatman on board who is responsible for regular activities such as maintenance and repair jobs. The need for new competencies in remote vessel operations is urgent, and the current single-vessel-based operational model is not considered economically viable. The D3.3 report proposed a competency framework that includes roles for remote control center operators and supervisors, as well as able boatmen on remote-controlled craft. Proposed standards for professional qualifications on management and operational levels will be considered according to the CESNI framework, with adjustments made based on legislative frameworks and technical requirements. Before developing educational and training programs, it is recommended to accelerate the adoption process in CESNI and to establish required competencies for remote vessel operation qualifications. At present, the

European Standard for Qualifications in Inland Navigation has not adopted any standards for remote control operators.

It is evident that the advancement of automation technology calls for the establishment of competency standards for operators who would be operating and supervising remote control systems. Thus, it is essential to create and implement these standards in parallel with the rise of autonomous technology to ensure safe and efficient operations.

The development of standards for remote control operators is still in its infancy, with only DNV making significant progress. However, the maritime and inland waterway transport industries are waiting for remote control vessels to become more actively involved in global trade before they begin to seriously contemplate the necessity for the establishment of standards and guidelines in this field. Until then, it is likely that the current minimal levels of regulation and guidance will remain in place.

Considering the ongoing developments in remote control vessel technology, it is probable that the establishment of remote-control standards and training will follow a similar trajectory as the Electronic Chart Display and Information System (ECDIS) standards for training. As ECDIS technology became more widely adopted, it became clear that crew training was critical to its effective use. IMO recognized this and in 1995 issued a resolution recommending that training in the use of ECDIS be included in STCW. Following the IMO's recommendation, various maritime authorities began to develop and implement standards for ECDIS training. Over time, the standards for ECDIS training have become more standardized, with the IMO issuing its first model course on ECDIS training in 2012. This model course provides guidance on the knowledge, skills, and competencies required to use ECDIS effectively and safely.

In the same manner, initially, remote control will be introduced on a limited number of vessels, gradually becoming standardized and widespread. Following this, it may be expected that an international standard will be established for remote control operators in general. Given that multiple organizations worldwide are involved in developing the technology, it is anticipated that operators will need to undergo a type-specific course for the intended remote-control center. This will enable them to possess a more comprehensive understanding of the equipment, systems, and processes they will encounter in their respective roles and ensure a greater degree of proficiency and competence in remote vessel operations.

The implementation of remote-control operation will face challenges despite its contribution to safe navigation. Officers who attend remote-control operation training and complete familiarization may still not be confident or competent when it comes to critical safety settings. Although there is ongoing work to ensure the effective use of remote-control operation, it is important to understand that specific and periodic training is necessary, as digitalization at sea is expanding into all aspects of seafarers' tasks.

Since the effectiveness of a system is dependent on its users, training should extend beyond simply checking off the equipment manufacturers' manual and the possible future IMO-mandated training. However, the diversity and fragmentation of digital system training programs may result in the absence of the best practice benchmark for ship remote-control operators to aspire to. Additionally, there is a lack of knowledge sharing between vessel remote-control developers and training organizations on effective real-life approaches and practical challenges.

Future implementation in maritime education

In light of the rapid expansion of digitalization and remote-control technologies in the maritime industry, it is imperative that maritime education and training (MET) facilities remain vigilant and attentive to the evolving landscape. As such, organizations such as DNV and platforms such as PLATINA3 have been at the forefront of developing standards and guidelines to ensure the safe and effective use of remote-control technologies. Nonetheless, it is the responsibility of MET institutions to remain up to date with these advancements and incorporate them into their curricula accordingly. The future of the maritime industry is inching towards the the use of remote-control centers, which will necessitate the deployment of trained operators. In response, MET facilities must adapt their educational programs to encompass the technical knowledge and practical skills required of such operators. To achieve this, these necessary requirements must be satisfied: a comprehensive understanding of the remote-control technologies in use, a sound grasp of the operational procedures involved, and a thorough awareness of the safety implications and risks associated with the use of these technologies [16]. In order for MET to achieve their ultimate objective of adequately preparing and training future operators for remote control vessels, there are three prerequisites that must be met.

In order to effectively prepare future remote control vessel operators, the first and foremost prerequisite is the provision of highly detailed, comprehensive, and globally recognized standards for training, which will serve as the foundation upon which institutions can establish their training programs. It is imperative that these standards are developed to the highest degree of quality and accuracy in order to ensure that the training provided meets the industry's exacting requirements. Furthermore, in order to guarantee the quality of training offered, a robust certification framework must also be established to ensure that only those institutions which meet the requisite standards are authorized to provide the training. Given the highly specialized nature of the training and the complex equipment involved, not every institution will possess the necessary resources to offer training of a sufficiently high caliber. Therefore, it is essential that a comprehensive and rigorous certification system is established to safeguard the quality and efficacy of the training provided.

In order to successfully prepare and train future operators, the second prerequisite that MET facilities must fulfill is to provide access to specialized remote-control simulators that are specifically designed for

training purposes. Existing simulators are generally designed to accommodate multiple users, making them unsuitable for operator training, as they require the operation of different instruments and controls by different individuals simultaneously. This design is not compatible with the concept of a single operator monitoring and controlling all aspects of navigation, with all controls within easy reach. As a result, MET facilities will have to invest in new simulation stations that are specifically designed for remote-control operation training, which will require not only new hardware but also new software. Given the expected demand for remote-control training, it is likely that major simulator software brands are already developing similar software for remote-control stations or are planning to do so in the near future.

The third and final prerequisite pertains to the trainers responsible for imparting the necessary skills to future remote-control operators. A significant question that arises is, what credentials are required for a trainer to deliver adequate training? Would practical experience as a remote-control operator or a seafarer, or both, be necessary? Furthermore, what specific competencies should trainers be capable of imparting to trainees to ensure their proficiency in operating remote-control vessels? These are critical issues that, despite their relevance, will likely be addressed last in the process of preparing MET facilities for providing adequate training for remote-control operators.

Conclusion

In conclusion, the advancement of automation technology requires the establishment of competency standards for operators who will operate and supervise remote control systems. DNV has made substantial progress in this area and has introduced the first competence standard for operators of ship remote control centers along with a recommended practice for a certification scheme. The inland water transport sector also needs new competencies for nautical inland shipping personnel involved in remote operations. The current state of development of standards for remote control operators is still in its embryonic stage, and the maritime and inland waterway transport industries are waiting for remote control vessels to become more actively involved in global trade before seriously contemplating the necessity for establishing standards and guidelines in this field. The implementation of remote-control operation will face challenges despite its contribution to safe navigation. Therefore, it is important to understand that specific and periodic training is necessary, as digitalization at sea is expanding into all aspects of seafarers' tasks.

Notes

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